

Mark Center (BRAC 133) Transportation Study

Prepared for

City of Alexandria, Virginia



Prepared by



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Transportation | Land Development | Environmental Services



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Executive Summary

The purpose of Mark Center (BRAC 133) Transportation Study was to identify and evaluate potential transportation improvements to the study area intersections and roadways that are located in the vicinity of Mark Center where 6,409 Department of Defense (DoD) personnel will be relocated to a new office complex being developed by year 2011 as part of the Base Realignment and Closure Commission's Recommendation # 133 (BRAC 133).

This document summarizes traffic operations at a total of fifteen intersections in the vicinity of the project study area, under both existing and future conditions. A number of potential conceptual alternatives which would be anticipated to improve the overall operation of the study area intersections and roadways were evaluated. Evaluation of the operational benefits associated with each alternative was completed initially through Synchro analysis at the individual intersections. Micro-simulation traffic analysis was then performed for the selected scenarios using VISSIM as a supplement to the HCM output results obtained from Synchro analysis. This was done in order to examine more in detail, especially during the heavy congested situations, how the operation and traffic flow of an individual intersection affect adjacent intersections and how traffic would move through the system as a whole. Therefore the results from the micro-simulation analysis would be expected to provide more detail, close to reality output. The operational attributes of each scenario were quantified according to a variety of performance-based measures-of-effectiveness and the relative benefits and disadvantages of each alternative are documented in this study. The following is a list of the conceptual alternatives evaluated for this study:

- Concept 1 : 2013 Project volumes with direct access ramp to the South parking garage
- Concept 2 : 2013 Project volumes with direct access ramp to Mark Center
- Concept 3 : 2013 Project volumes with direct access ramps to the South parking garage and Mark Center
- Concept 4 : 2013 Project volumes with added left turn lanes at Seminary Rd / N. Beauregard St intersection along westbound Seminary Rd (triple left) approach and at N. Beauregard St / Mark Center Dr intersection for southbound N. Beauregard St (dual left) approach without direct access ramps

- Interim Solution for the period between 2011 and 2013 in order to accommodate the project trips for the periods from BRAC occupancy anticipated by 2011 and the anticipated construction of the new ramp by 2013.

The capacity analysis and micro-simulation results suggest that that all of the evaluated alternatives would be expected to provide operational benefits. However, depending on the concept, the expected benefit and disadvantages would vary. The overall findings from the capacity and micro-simulation analyses can be summarized as follows:

- Although there are operational benefits, Concept 4 (additional left turn lane improvements) would still need new direct access, since some of the critical intersections serving the Mark Center site would operate over capacity without any additional direct access and would not be able to accommodate significant number of the additional project trip demand during AM and PM peak hour conditions. Concept 4 also has limitations in terms of improving the operations for the project trips egressing from the project site during PM peak hour conditions.
- Safety and roadway functioning operational issues would also be of a concern when having only Concept 4 to accommodate all the project trips. Therefore, additional improvement measures would need to be considered such as providing direct access ramps in combination with adding the additional left turn lanes, lengthening of the storage bays especially for the left turns at the critical intersections, lane widening for the left turn receiving lanes and improving the signage and pavement markings for these critical left turn movements.
- For Concept 1 (direct access to the South Parking Garage), additional left turn lanes at the critical intersections would still be needed since the intersection is at capacity and would not serve all the project demand.
- Concept 2 can serve most of the demand without an additional left turn lane along the Seminary Road westbound approach at the intersection of Seminary Road / N. Beauregard Street. Concepts 2 and 3 would maximize operational benefits in terms of traffic operations, but at the same time would be most difficult to implement from a construction standpoint. Major construction efforts would be required due to grade separating the access ramp under tight spacing requirements. In addition, current geometry of the I-395 southbound on ramp would require reconfiguration with the removal of the free right turn channelized ramp and addition of the dual right turns lanes instead at this intersection which would deteriorate the operations at this intersection. Also, it would still be necessary to provide additional left turn lanes at the

critical intersections in order to accommodate the additional trips generated from the future developments that will occur in the vicinity of the BRAC 133 project site.

- To ensure the full operational benefits of implementing Concepts 1, 2 or 3, it is important to take proper measures to prevent any spillback onto the I-395 southbound on ramp from the new direct access ramps. For Concept 1, as an example, measures would need to be taken at the security screening point to process the entering vehicles efficiently by providing multiple inspection gates and/or installing electronic screen vehicle tags as well as providing a sufficient storage length. For Concept 2, traffic circulation within the internal roadways would need to be maintained in an acceptable manner as well as providing a sufficient storage length for vehicles accessing the site.

Potential interim solutions were also investigated in order to accommodate the project trips for the periods from BRAC occupancy anticipated by 2011 and the anticipated construction of the new ramp by 2013. The findings from the interim solutions are as follows:

- Although some operational benefits would be attainable by increasing the storage length for the critical left turn movements, the intersections would still operate over capacity at the critical intersections. Therefore, expediting the construction of placing additional left lanes by 2011 (Concept 4) as an interim year improvement measure and then constructing the direct access ramps by 2013 or earlier would be one interim option to consider in order to improve the operations during year 2011 and ultimately in year 2013.
- Potential developments in Beauregard Corridor Plan Area which may be developed in the vicinity of the Mark Center may generate approximately 1,000 additional trips during AM peak hour and 1,500 additional trips during PM peak hour conditions. Therefore, even after the year 2013, it would be beneficial to keep the interim improvements in place to accommodate the additional trips generated from the potential future developments that may occur in the vicinity of the project site.

1. Introduction

Vanasse Hangen Brustlin, Inc. (VHB) has prepared the Mark Center (BRAC 133) Transportation Study to document an evaluation of potential transportation improvements to the study area intersections and roadways that are located at Mark Center within the City of Alexandria, Virginia. The improvement measures need to be identified since 6,409 Department of Defense (DoD) personnel will be relocated to a new office complex being developed at Mark Center by year 2011 as part of the Base Realignment and Closure Commission's Recommendation # 133 (BRAC 133). The new complex will add two (west and east tower) buildings, two (south and north) parking garages and a public transportation center which will be attached to the north parking garage. Currently there are already three existing buildings (4850, 4825, and 4900 Buildings) and one parking garage associated with 4900 building in the immediate vicinity of the BRAC 133 site within Mark Center.

The study was performed in three stages:

- Previous traffic studies in the vicinity of Mark Center, including a traffic impact study and a transportation management plan prepared directly for the BRAC 133 development were reviewed to assess the consistency of these studies with current Mark Center development and parking plans. Major focus was given to the BRAC 133 Transportation Management and Improvement Plan (TMIP) prepared by Wells & Associates in July 2008 and the Mark Center (BRAC) Transportation Study prepared by VDOT in April 2009. Additional studies reviewed include I-95/I-395 HOV/Bus/HOT Lanes Interchange Justification Report (IJR) (January 2009 - HNTB), I-95/I-395 Transit/TDM Study (February 2008 - Technical Advisory Committee), Seminary – Beauregard Corridor Study (January 2007 - Wilbur Smith Associates), 2003 Mark Center Traffic Impact Study (March 2003 - Wells & Associates), and ongoing VDOT I-395 IJR at Seminary Road Study. Technical Memoranda that summarize the findings from these reviews are included in the **Appendix A** and **B**.
- An assessment was made to determine the advantages and disadvantages of adding a new direct access ramp connection to either BRAC 133 South parking garage or Mark Center, or both of these access points. For these concepts, detail evaluation was performed to determine whether there would be a need for adding additional left turn lanes at the Seminary Rd/ N. Beauregard St and N.Beauregard St / Mark Center Dr intersections in light of the potential addition of a new direct ramp connection into Mark Center from the southbound ramp to

southbound I-395. For this purpose, the recommendations provided from the previous studies were also reviewed and additional potential improvement measures were evaluated.

- Interim solutions to be implemented between the time that the BRAC building is occupied and construction of the new ramp were assessed, as well as the traffic impacts of not adding the additional left turn lanes.

The study area consists of approximately a 1.2 mile section of Seminary Rd, bounded by George Mason Dr to the west and Library Ln to the east which includes ramps at I-395 and Seminary Rd, in the City of Alexandria. Additionally, approximately a 0.42 mile section of N. Beauregard St is part of the study area, bounded by Mark Center Dr to the south and W. Braddock Rd to the north. The study area is illustrated in **Figure 1**.

2. Study Methodology

The traffic assessment was conducted in three stages. The first stage involved an assessment of existing traffic conditions within the project area, including an inventory of existing roadway geometry, observations of traffic flow, and collecting peak period traffic counts at the roadways and intersections within the study area. This study assessed weekday AM peak hour and PM peak hour conditions.

The second stage of the study involved an evaluation of potential improvement alternatives for the study area, accounting for the diversion and redistribution of BRAC 133 and Mark Center project trips. Each of the alternatives was assessed and future traffic volumes were established and assigned to the study area roadways. The year 2013 was selected as the design year for all future conditions analysis. The traffic analysis conducted in this second stage identified the operational benefits and drawbacks of each potential improvement alternative. A two-tiered analysis approach, involving the use of a discrete, location-based analysis tool (Synchro) and then micro-simulation analysis (VISSIM), was used to evaluate the traffic operations.

The third stage of the study identified and evaluated a potential interim solution to be implemented in order to accommodate the project trips between periods from BRAC occupancy anticipated by 2011 and the anticipated construction of the new ramp by 2013.

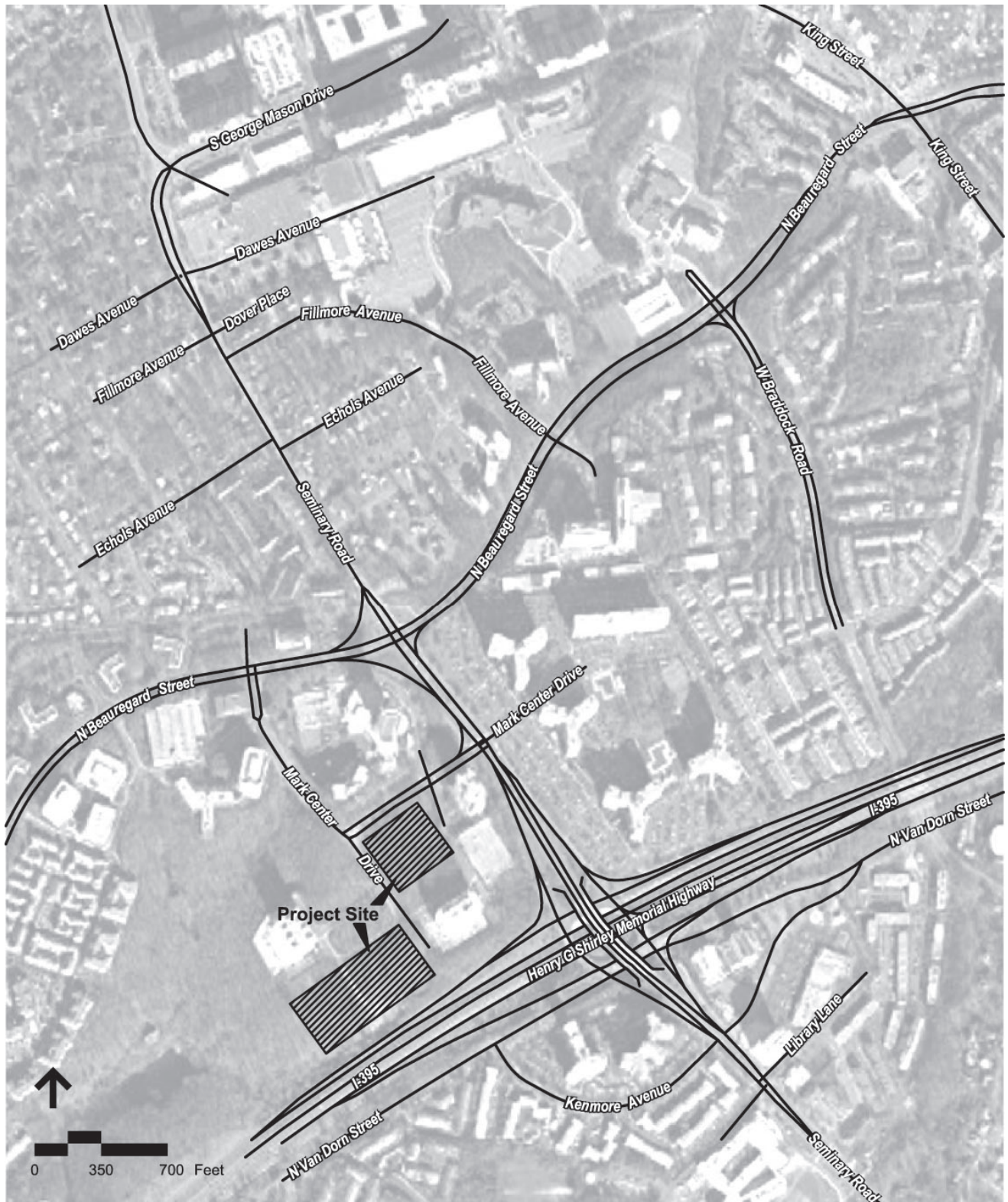


Figure 1: Study Area

3. Existing Conditions

3.1. Roadway Characteristics

Within the study area, several roadways comprise the roadway system. Roadway characteristics and land uses along these major roadways are described as follows:

Seminary Road

Seminary Road runs in the east-west direction and connects to Library Ln to the east and extends westwards to I-395, Mark Center Dr, N. Beauregard Street, and George Mason Dr. Seminary Rd is mostly a six-lane divided arterial with a posted speed limit of 35 mph between Library Ln and N. Beauregard St with an exception at I-395 interchange where Seminary Rd overpass is a four-lane divided arterial. West of N. Beauregard St, Seminary Rd is mostly a four-lane undivided arterial. Within the study area along segments east of the intersection with N. Beauregard Street, Seminary Road serves access to office complexes and intersection with Mark Center Dr serves access to Mark Center site. Roadway segments west of the intersection with N. Beauregard Street serve as access to residential and commercial areas.

North Beauregard Street

North Beauregard Street, which runs in the north-south direction, is a four-lane divided facility with posted speed limits of 35 mph. The Intersection with Mark Center Dr mainly serves access to the Mark Center site. To the north of the study area, N. Beauregard St connects to King Street while to the south of the study area, connects to Duke Street. Roadway segments serve as an access to office complexes, commercial developments and residential areas.

Mark Center Drive

Mark Center Drive although there are no lane markings striped along the pavement, it is wide enough to accommodate two lanes for each approach. Mark Center Drive serves as the internal roadway within Mark Center development and connects N. Beauregard Street and Seminary Road. The north leg of the intersection of Mark Center Drive and Seminary Road is a driveway for the Southern Towers residential complex.

Within the study limits, thirteen signalized and two unsignalized intersections were identified. Previous traffic studies prepared for the study location were reviewed and if available, turning movement counts collected as part of these prior studies were initially used in establishing existing condition volumes. The following is a list of the major signalized and unsignalized intersections within the study area that have been analyzed:

1. Seminary Road / N. Beauregard Street
2. N. Beauregard Street / Mark Center Drive
3. Seminary Road / Mark Center Drive
4. Mark Center Drive / Hilton / CNAC Drive
5. Mark Center Drive / IDA Drive
6. I-395 Southbound Off-Ramp / Seminary Road
7. I-395 Southbound On-Ramp / Seminary Road
8. I-395 Northbound Off-Ramp / Seminary Road
9. I-395 Northbound On-Ramp / Seminary Road
10. Seminary Road / Library Lane
11. Seminary Road / George Mason Drive
12. Seminary Road / Dawes Avenue
13. Seminary Road / Echols Avenue
14. N. Beauregard Street / Fillmore Avenue
15. N. Beauregard Street / West Braddock Road

Geometry configurations at the study intersections are depicted in **Figure 2** which shows the type of intersection control, intersection geometry, and the lane usage. Among these study intersections, this evaluation provides a particular focus on the critical intersections that serve as the existing access and egress points to the Mark Center site, which are Seminary Road / N. Beauregard Street, Seminary Road / Mark Center Drive and N. Beauregard Street / Mark Center Drive intersections.

Within the study area, pedestrian facilities are installed at some of the study intersections. In the vicinity of the project site, at the intersection of Seminary Road / N. Beauregard Street, crosswalks are marked along the west leg of Seminary Rd, and north and south legs of Beauregard St. However, none of these crosswalks have push buttons or pedestrian signal heads under existing conditions. At the intersection of N. Beauregard Street / Mark Center Drive, crosswalks are marked along all approaches with push buttons and pedestrian signal heads installed, while at Seminary Road / Mark Center Drive intersection, pedestrian signal heads and push buttons are equipped and crosswalks are marked on west leg of Seminary Rd and north leg of the Southern Towers entrance.

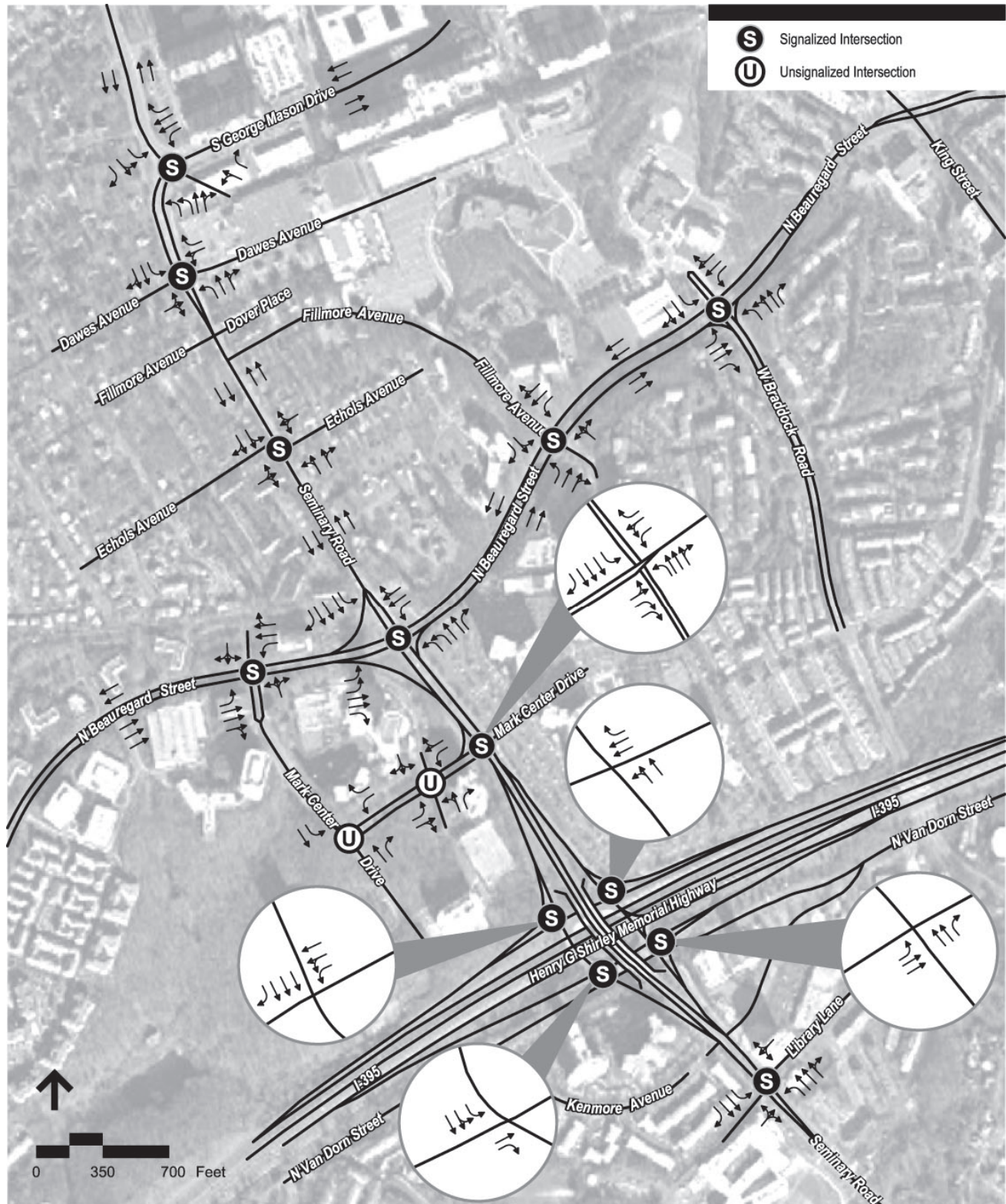


Figure 2: Existing Study Intersection Geometry

3.2. Vehicular Flows

Existing peak hour traffic volumes at the study intersection are summarized in **Figure 3**. Turning movement counts were collected in July 2009 from 7 AM to 9 AM and from 5 PM to 7 PM during the weekday condition at the intersections where prior count data was not available. The peak hour generally fell between 7:30 AM to 8:30 AM and 5:00 PM to 6:00 PM during the weekday. Where available, traffic volumes from the previous studies were used for the study intersections in establishing the existing conditions traffic volumes. The primary source of the counts were from BRAC 133 Transportation Management & Improvement Plan (July 2008 - Wells & Associates) and the 4661 Kenmore Avenue Traffic Impact Study (Kimley Horn & Associates). Traffic count volumes from prior studies and the newly counted data were then balanced to be used for the existing turning movement volume at the study intersections.

3.3. Traffic Operations

Methodology

The traffic analysis software program Synchro (Version 7, Build 773) was used to perform the traffic operational analysis of the study intersections. Synchro network files were developed for this analysis and signal timing information was obtained from the City of Alexandria and VDOT, which were incorporated into the Synchro datasets. The turning movement data and physical geometric configuration data provide the basis for evaluation of traffic operations at each intersection. The evaluation criteria used to analyze area intersections and roadways in this traffic evaluation are based on the 2000 *Highway Capacity Manual* (HCM).¹ The HCM methodology results in various output parameters, referred to as Measures-of-Effectiveness (MOEs), including level-of-service. Level-of-service (LOS) is the term used to denote the different operating conditions that occur on a given roadway segment under various traffic volume loads. Level-of-service is a qualitative measure that considers a number of factors including roadway geometry, speed, travel delay and freedom to maneuver. Level-of-service provides an index to the operational qualities of a roadway segment or an intersection.

¹ Transportation Research Board, *Highway Capacity Manual*, Washington, D.C., 2000

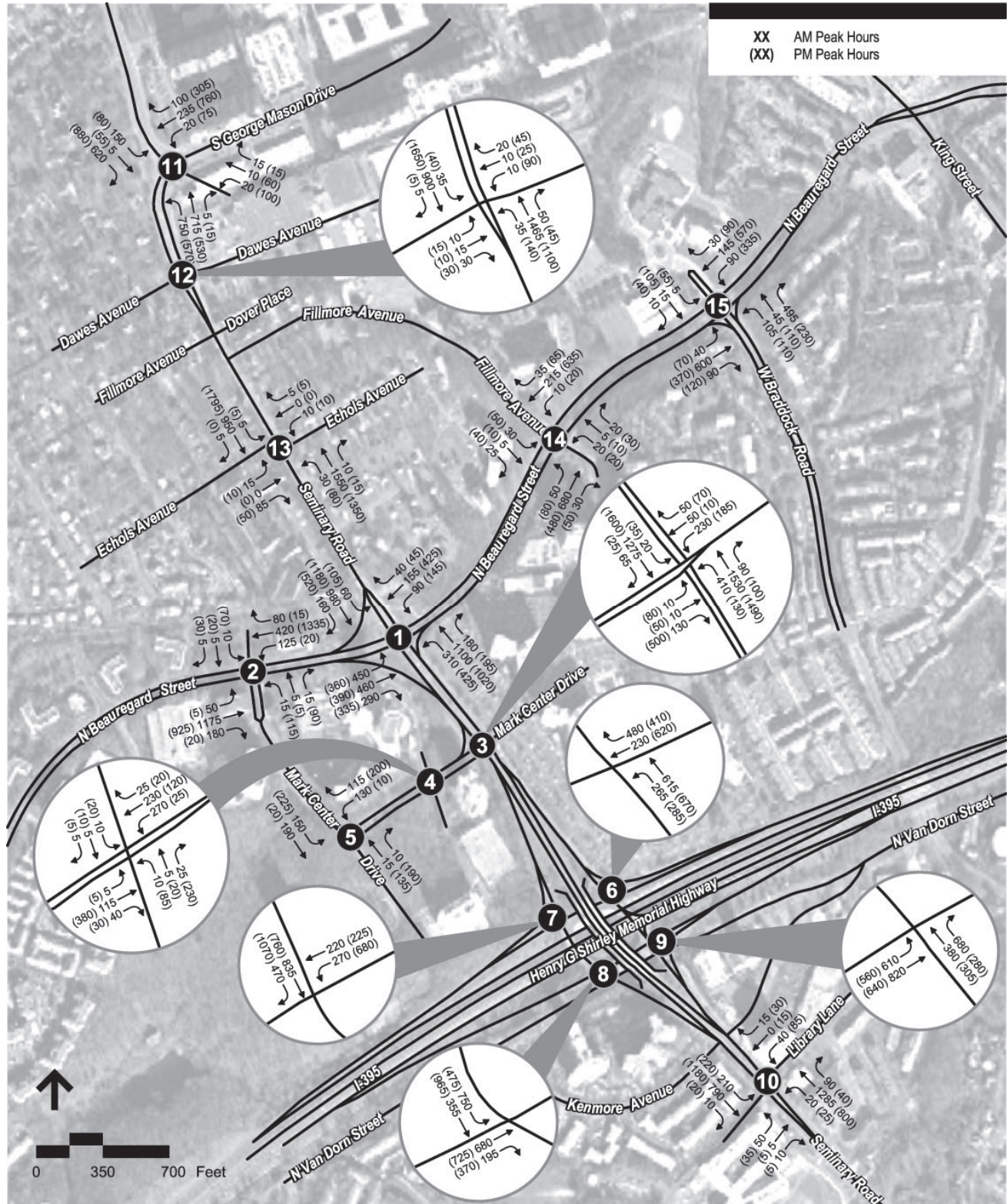


Figure 3: Existing Peak Hour Volumes

Level-of-service designations range from A to F, with LOS A representing the best operating conditions and LOS F representing the worst operating conditions. For signalized intersections, the analysis considers the operation of all traffic entering the intersection and a LOS designation is provided for overall conditions at the intersection. At both signalized and unsignalized intersections, two other MOEs are typically used to quantify traffic operations, in addition to LOS. These are volume-to-capacity ratio (V/C) and delay (expressed in seconds per vehicle). For example, an existing V/C ratio of 0.9 for an intersection indicates that the intersection is operating at 90 percent of its capacity. A delay of 15 seconds for a particular vehicular movement or approach indicates that vehicles on the movement or approach will experience an average additional travel time of 15 seconds. These additional MOEs (V/C and delay) have ranges of values for a given LOS letter designation. Comparison of intersection capacity results therefore requires that, in addition to the LOS, the other MOEs should also be considered.

Capacity Analysis

The study area intersections were analyzed for their operational performance using the HCM module within the Synchro software. **Table 1** presents the MOE results for each signalized intersection during the existing weekday morning, and weekday evening peak hour conditions. The results in **Table 1** indicate that all of the study intersections are operating acceptably with LOS D or better except at the following intersections. The I-395 NB Off-ramp / Seminary Rd intersection currently operates over capacity with LOS F during the AM and PM peak hour conditions due to heavy I-395 northbound off-ramp volumes. In addition, the Seminary Rd / George Mason Dr intersection is operating over capacity with LOS F due to heavy eastbound and southbound volumes during the PM peak hour conditions.

Analyses are currently being performed by VA Megaprojects GEC as part of the preparation effort for the I-395 Interchange Modification Report (IMR) at Seminary Road. The study area being analyzed overlap for both studies, and therefore some coordination efforts were made by the two study teams. Since I-395 IMR at Seminary Road Study is at the initial stage of the study, coordination efforts were limited to comparing the established existing traffic count data and sharing the existing condition analyses network files. The comparison of the analyses results for the existing conditions between the two studies showed that the overall reported LOS were fairly similar at the study intersections for both AM and PM peak hour conditions, especially at the critical study intersections.

Table 1: Existing Conditions Intersection MOEs

No.	Intersection Location	Control Type	Existing AM Peak Hour Condition			Existing PM Peak Hour Condition		
			V/C	LOS	Delay (sec/veh)	V/C	LOS	Delay (sec/veh)
1	Seminary Rd / N. Beauregard St	Signal	0.72	D	46.0	0.87	D	51.7
	Eastbound			D	44.6		D	48.1
	Westbound			C	32.1		C	32.5
	Northbound			E	64.8		F	84.0
	Southbound			D	50.0		E	56.9
2	N. Beauregard St / Mark Center Dr	Signal	0.39	A	6.8	0.63	B	13.2
	Eastbound			D	49.5		D	43.2
	Westbound			D	49.8		E	58.1
	Northbound			A	6.3		A	8.5
	Southbound			A	4.2		A	6.9
3	Seminary Rd / Mark Center Dr	Signal	0.71	C	24.7	0.64	C	23.0
	Eastbound			B	12.4		B	12.3
	Westbound			C	27.8		C	20.5
	Northbound			C	33.5		D	46.6
	Southbound			D	52.2		D	49.4
4	Mark Center Dr / Hilton / CNAC Dr	Stop Sign	n/a	A	2.8	n/a	A	6.7
	Eastbound			A	0.1		A	0.1
	Westbound			A	3.7		A	1.3
	Northbound			B	12.3		C	15.7
	Southbound			B	14.9		D	25.0
5	Mark Center /IDA Dr	Stop Sign	n/a	B	11.1	n/a	A	9.8
	Eastbound			B	11.9		B	11.6
	Westbound			A	7.3		A	8.6
	Southbound			A	9.1		A	9.5
6	I-395 SB Off-ramp / Seminary Rd	Signal	0.34	B	12.4	0.5	C	28.9
	Southbound (I-395 SB Off-ramp)			C	22.2		D	52.6
	Westbound			A	4.4		A	3.4
7	I-395 SB On-ramp / Seminary Rd	Signal	0.41	C	34.9	0.7	C	21.9
	Southbound			A	5.0		A	3.4
	Eastbound (I-395 SB On-ramp)			D	46.2		C	31.1
8	I-395 NB Off-ramp / Seminary Rd	Signal	0.64	F	103.7	0.75	F	106.9
	Northbound (I-395 NB Off-ramp)			F	233.1		F	245.7
	Eastbound			A	1.3		A	1.4
9	I-395 NB On-ramp / Seminary Rd	Signal	0.47	B	11.4	0.41	B	13.2
	Northbound			A	0.6		A	2.1
	Westbound (I-395 NB On-ramp)			C	26.0		D	36.0
10	Seminary Rd / Library Ln	Signal	0.60	A	9.7	0.56	B	14.5
	Eastbound			A	4.4		A	8.9
	Westbound			A	9.8		B	14.1
	Northbound			E	57.0		D	45.0
	Southbound			D	49.9		E	68.0

Note: Results are from the HCM module in Synchro.

No.	Intersection Location	Control Type	Existing AM Peak Hour Condition			Existing PM Peak Hour Condition		
			V/C	LOS	Delay (sec/veh)	V/C	LOS	Delay (sec/veh)
11	Seminary Rd / George Mason Dr	Signal	0.47	C	28.3	0.9	F	107.8
	Eastbound (Seminary Rd)			C	22.8		D	42.5
	Westbound (Seminary Rd)			C	30.9		D	44.3
	Southbound (S George Mason Dr)			D	36.7		F	261.4
	Northbound (Shopping Plaza)			D	39.1		D	47.9
12	Seminary Rd / Dawes Ave	Signal	0.54	A	5.5	0.72	B	15.5
	Eastbound			A	4.6		B	13.7
	Westbound			A	3.3		B	12.2
	Northbound			D	50.7		D	45.1
	Southbound			D	50.0		D	50.8
13	Seminary Rd / Echols Ave	Signal	0.63	A	8.2	0.86	C	22.2
	Eastbound			A	9.4		B	12.3
	Westbound			A	4.3		C	33.0
	Northbound			D	50.7		D	51.9
	Southbound			D	54.5		D	54.5
14	N. Beauregard St / Fillmore Ave	Signal	0.28	B	10.2	0.35	B	12.7
	Eastbound			D	43.5		D	44.0
	Westbound			D	46.3		D	46.5
	Northbound			A	6.8		B	12.4
	Southbound			A	5.9		A	5.7
15	N. Beauregard St / W Braddock Rd	Signal	0.32	C	29.5	0.46	D	47.4
	Eastbound			D	50.4		D	48.6
	Westbound			D	51.6		D	50.4
	Northbound			B	10.6		B	17.0
	Southbound			C	25.2		E	62.8

Note: Results are from the HCM module in Synchro.

3.4. Transit Services

The public bus routes that operate within the study area, and roadways served by these bus routes within the study area are summarized in **Table 2**. Metrobus and Alexandria Transit Company (DASH) routes serve the study area with stop locations located along the main roadways as illustrated in **Figure 4**. Also, during AM, noon, and PM peak hours, Duke Realty Corporation operates shuttle bus service between Mark Center and the Pentagon Metro Station. In addition, the existing CNAC and IDA facility also operate private shuttle bus services from Mark Center and the Pentagon Metro Station.

Table 2: Bus Routes Serving Areas Vicinity to Mark Center

Bus Routes	Roadways Served
Metrobus 7A, 7B, 7D, 7E, 7F, 7W, 7X	Lincolnia-North Fairlington Line Travels along N. Beauregard St, Mark Center Dr, Seminary Rd, Southern Towers
Metrobus 8W, 8X, 8Z	Foxchase-Seminary Valley Line Travels along Seminary Road, Kenmore Ave, N. Van Dorn St
Metrobus 16 L	Annandale-Skyline City-Pentagon Line Travels along Seminary Road
Metrobus 25B, 25C, 25D	Landmark-Ballston Line (25 B), Ballston-Bradlee-Pentagon Line (25 C, D) Travels along Seminary Road, N. Beauregard St, Braddock Rd
Metrobus 28B, 28F, 28G	Alexandria-Tysons Corner Line (28 B) Alexandria-Tysons Corner Line (28 F, G) Travels along Seminary Road, N. Beauregard St, Southern Towers
DASH AT1	To Seminary Plaza (Northbound - Eisenhower Metro and Van Dorn Metro to Southern Towers and Seminary Plaza), Travels along Seminary Rd, Kenmore Ave
	To Van Dorn Metro and Eisenhower Metro (Southbound - Seminary Plaza to Van Dorn Metro and Eisenhower Metro), Travels along Seminary Road
DASH AT2	To Braddock Metro Via Old Town (Eastbound - Lincolnia to Braddock Metro via Old Town Alexandria, Travels along Seminary Road
	To Lincolnia (Westbound - Braddock Metro to Lincolnia via Southern Towers), Travels along Seminary Road
DASH AT5	To Braddock Metro Via Old Town (Eastbound- Van Dorn Metro to Braddock Metro via Old Town Alexandria), Travels along Seminary Road
	To Landmark, Van Dorn M (Westbound -Braddock Metro to Landmark Mall and Van Dorn Metro, Travels along Seminary Road

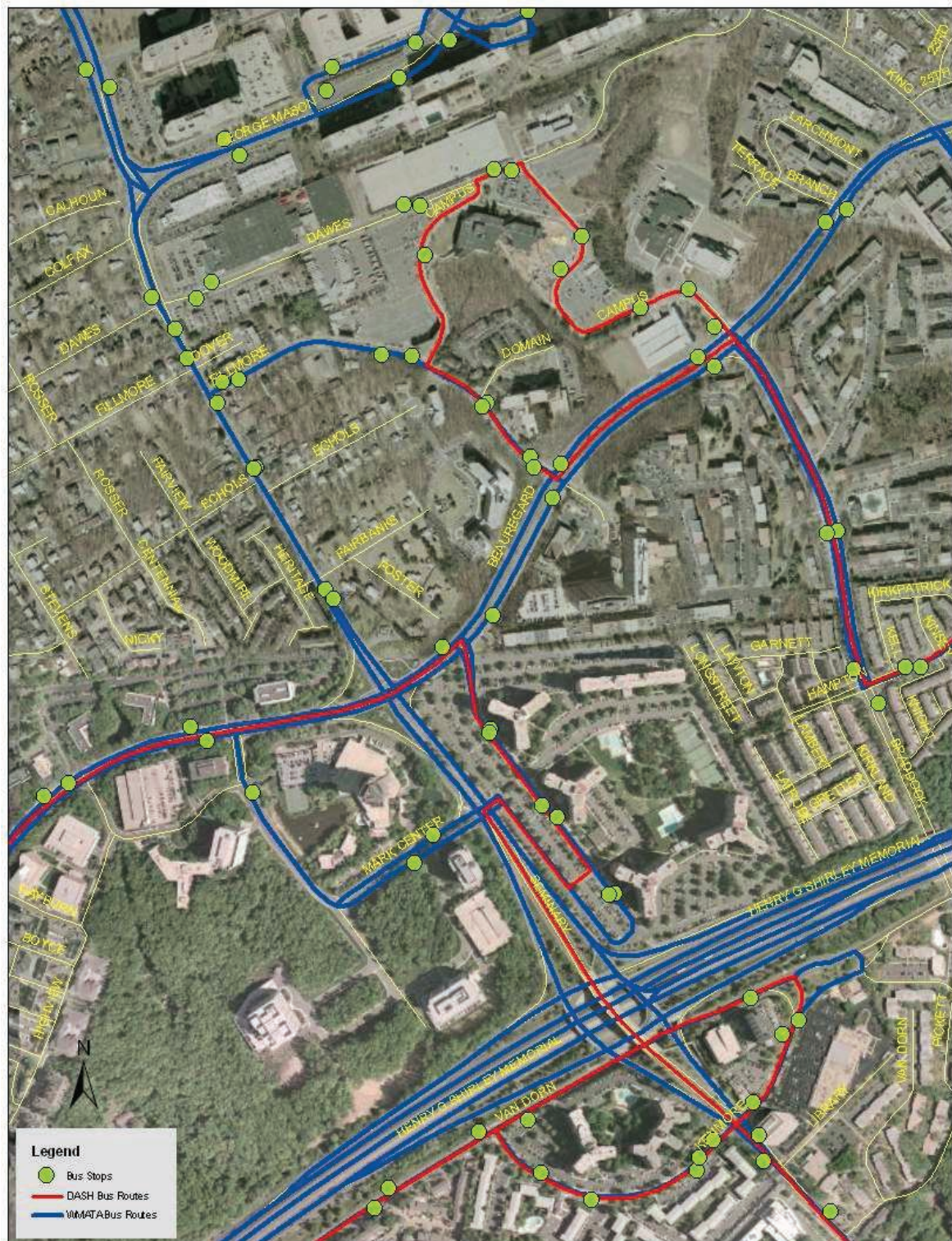


Figure 4: Existing Metrobus and DASH Bus Routes

4. Future Conditions – 2013 Baseline Conditions without Additional Left Turn Lanes

The future baseline conditions assumed 2013 as the target year for the traffic analysis. Since BRAC 133 site is scheduled to be completely built out and the relocation is anticipated to occur in 2011, the future baseline volumes developed at the study intersections within the study area accounted for BRAC 133 as well as the IDA 5 expansion proposed within Mark Center site. The 2013 baseline conditions were defined following the procedure outlined below.

4.1. Vehicular Flows

Weekday AM and PM peak hour traffic projections for the study intersections for the 2013 baseline conditions were developed first by determining the magnitude of the anticipated background growth on a yearly basis for the roadways within the study area. For this purpose the Metropolitan Washington Council of Governments' (MWCOC) Travel Demand Model network was reviewed and appropriate annual traffic growth factors for the local road network within the study area were derived based on average daily traffic assignment outputs of the MWCOC travel demand model. The average growth rate for the roadways within the study area from 2010 to 2020 showed 0.51 percent growth per year, which was then applied to the existing turning movement volumes in order to account for the anticipated background growth. Therefore, traffic projections for 2013 Baseline Condition assuming BRAC Occupancy with no new ramp or intersection improvements were developed by first applying 0.5% growth per year universally to the existing volume. In addition, the BRAC 133 Building, IDA Building 5 and 4661 Kenmore Avenue developments were all assumed to be fully built out by 2013 and the corresponding trips were reflected in the 2013 baseline assignment.

In order to determine the project trips generated by the BRAC 133 development, the number of employees working during the day shift in relation to the available parking spaces for the auto-driver employees and visitor trips were reviewed and summarized as shown in **Table 3**. At the proposed BRAC 133 site, the total number of employees will be 6,409 while the north garage will have 2,044 spaces and the south garage 1,854 spaces with total of approximately 3,900 spaces. Out of the total 3,900 spaces, it was assumed that 95% occupancy of the parking garages would be considered as full in order to allow smooth circulation within the facility. The number of auto-driver visitors was estimated by first

assuming that the visitors will be 5% of the employees present during the day shift and then assuming 60% of those visitors will be driving a vehicle to the facility. Therefore, the total parking spaces occupied for each scenario were calculated by combining the auto-driver employee and visitor occupied spaces.

Table 3: Percentage of Employees during the Day Shift in Relation to Available Parking Spaces

Percentage of Total Employees Present During the Day Shift	Number of Employees Present During the Day Shift	Auto-Driver Employee with TMP (40% vehicle reduction in Place)	Number of Visitors (Assumes 5% of employee present)	Auto-Driver Visitor with TMP (40% vehicle reduction in Place)	Total Occupied Spaces	Available Parking Spaces (assuming 95% occupancy as being full)
95%	6,089	3,653	304	183	3,836	0
90%	5,768	3,461	288	173	3,634	71
85%	5,448	3,269	272	163	3,432	273
80%	5,127	3,076	256	154	3,230	475
75%	4,807	2,884	240	144	3,028	677

In this analysis 85% of the total employees would be assumed to be present during the day shift for future built out conditions as shown in **Table 3**. This assumption will be in the mid-range between the trip generation proposed in the BRAC 133 TIMP, where the percent present on average day is 75% (assuming out of 83% scheduled to work day shift with 10% would be absent due to illness, vacation, travel etc) and in the VDOT Mark Center (BRAC) Transportation Study where the percent scheduled to work the day shift equated to 96%. Therefore, the trip generation estimates summarized in **Table 4** were assumed in analyzing the 2013 baseline conditions.

(1)

Table 4: 2013 Baseline Conditions Trip Generation

	AM Peak Hour			PM Peak Hour		
	In	Out	Total	In	Out	Total
BRAC 133 including Employees and Visitors ⁽¹⁾	1,195	79	1,274	148	1,195	1,343
Additional Project Trips Occupying the Available 273 Parking Spaces (40% during peak hour)	110	0	110	0	110	110
IDA 5 ⁽¹⁾	413	57	470	74	359	433
4661 Kenmore Avenue Development (Medical Office Bldg) ⁽²⁾ (Based on Sq.ft.)	205	55	260	89	241	330
Total	1,923	191	2,114	311	1,905	2,216

Note: (1) BRAC 133 Transportation Management and Improvement Plan (TMIP) prepared by Wells & Associates in July 2008

(2) 4661 Kenmore Avenue Traffic Impact Study prepared by Kimley Horn & Associates in December 2008

The VDOT Mark Center (BRAC) Transportation Study also assumed the same number of employees, but assumed more project trips would be generated due to 831 vacant parking spaces which would encourage more people to drive to the facility rather than use other TMIP options. Therefore, in the VDOT Mark Center (BRAC) Transportation Study, it was assumed that 40% of these additional project trips which will be approximately 330 trips will occur during peak hour conditions. More detail descriptions and comparison of the different trip generation assumptions are provided in **Appendix A**.

In determining Trip distribution percentages were established based on the current residential distribution of potential BRAC 133 employees provided in the BRAC FEIS report. The current residential distribution was derived based on payroll data that also included employee density within zip code boundaries (employees/square mile). It was assumed that the current BRAC employees, in the short term, would maintain their current residential distribution after relocating to Mark Center. Using this information, project trip distributions were established in order to assess the direction of arrivals and departures by the BRAC 133 employees. Trip distribution assumed for the BRAC 133 employees are summarized in **Table 5**.

Table 5: 2013 Proposed Trip Distribution

Origin/Destination	Proposed Trip Distribution
To/From the North on I-395	20%
To/From the South on I-395	23%
To/From the East on Seminary Rd	20%
To/From the West on Seminary Rd	15%
To/From the North of N. Beauregard St	5%
To/From the South of N. Beauregard St	15%
To/From the North from Southern Towers	2%
Total	100%

This same distribution was assumed for the trips associated with IDA Building 5. For the 4661 Kenmore Avenue Development (Medical Office Bldg), trip distribution established as part of the 4661 Kenmore Avenue Traffic Impact Study was assumed.

The established project trips were distributed according to the trip distribution established for the 2013 conditions and **Figure 5** depicts the 2013 baseline turning movement volumes established at the study intersections after assigning the project trips onto the baseline condition. It was also assumed that the trips from I-395 ramps would be prohibited from making a immediate left turn once they merge onto Seminary westbound approach at Seminary Rd / Mark Center Dr intersection.



4.2. Traffic Operations

Using the turning movement volumes developed for the future baseline condition, a traffic operational analysis for the study intersections was performed using Synchro analysis software following a similar approach as used for analyzing the existing conditions. It was assumed that with the addition of the project trips it is anticipated that apart from any drastic geometry improvements, there would at minimum be some type of timing optimization and refinement at the signalized intersections in order to accommodate the added project trips. Therefore, as a first step, signal timings were optimized accounting the project volumes at the study intersections. Also, since the operations at I-395 NB Off-ramp / Seminary Rd intersection which currently is operating over capacity would further deteriorate with the added project trips, it was assumed that similar type of relatively minor improvement measures within existing right-of-way would be taken by 2013 in order to mitigate the current deficiency and to provide the additional capacity for the added project trips. In this regard, along with the signal timing improvement measures, restriping the lane marking at I-395 NB Off-ramp / Seminary Rd and I-395 NB On-ramp / Seminary Rd intersections were assumed. This includes converting the northbound right turn lane into a shared through and right turn lane at the I-395 NB Off-ramp / Seminary Rd intersection and also converting the northbound through lane into a shared left turn and through lane at the I-395 NB On-ramp / Seminary Rd intersection to provide additional capacity for the through and left turn movement. With these assumed improvement measures in place, the operations at the intersections with I-395 ramps would be expected to improve in 2013 conditions.

It was also assumed for the future baseline condition that at the intersection of Seminary Road / N. Beauregard Street, additional crosswalks would be marked along east leg of Seminary Rd in addition to the existing crosswalk marked along the west leg of Seminary Rd, and north/south legs of Beauregard St. For the future condition, it was assumed that pedestrian interval would be allocated at for all of the crosswalks marked at this intersection and push buttons and pedestrian signal heads would be installed. Under the existing condition, although there are currently crosswalks on the three approaches (West leg Seminary, North and South legs Beauregard) there are no pedestrians signal heads or push buttons on any of these crosswalks with no pedestrian interval provided.

With the assumption that BRAC 133 site and the IDA 5 expansion would be completed by 2013, the intersection of Mark Center /IDA Dr which is located within Mark Center site was also assumed to be improved from the previous three-legged unsignalized intersection to a four-legged signalized intersection to serve the added project trips.

Table 6 presents the Measures of Effectiveness (MOEs) for the study intersections under the 2013 baseline weekday AM and PM peak hour conditions within the study area. As shown in **Table 6**, operations at all of the intersections are expected to deteriorate in year 2013 for both morning and evening time periods due to increases in the projected traffic volumes within the study area, as compared to the existing conditions presented in **Table 1**. During AM peak hour conditions, mainly due to the addition of project trips accessing the project site, the Seminary Rd / N. Beauregard St and N. Beauregard St / Mark Center Dr intersections, which serve as the main access points to the project site, are anticipated to operate over capacity with LOS F. During PM peak hour conditions, Seminary Rd / Mark Center Dr and Mark Center Dr / Hilton / CNAC Dr intersections are expected to operate over capacity with LOS F mainly due to the project trips egressing the project site via these intersections. The Seminary Rd / George Mason Dr intersection is also expected to continue operating above capacity during PM peak hour conditions. All of the remaining study intersections would operate at LOS C or better during weekday AM peak hour conditions and at LOS E or better during PM peak hour conditions.

Table 6: 2013 Baseline Conditions Study Intersection MOEs without Additional left turn lanes

No.	Intersection Location	Control Type	2013 Baseline AM Peak Hour Condition			2013 Baseline PM Peak Hour Condition		
			V/C	LOS	Delay (sec/veh)	V/C	LOS	Delay (sec/veh)
1	Seminary Rd / N. Beauregard St	Signal	1.09	F	121.3	0.93	D	46.9
	Eastbound			F	121.3		C	33.1
	Westbound			F	122.9		D	42.8
	Northbound			F	130.7		E	63.1
	Southbound			E	79.0		E	72.0
2	N. Beauregard St / Mark Center Dr	Signal	1.34	F	109.6	0.85	C	30.1
	Eastbound			E	63.2		C	27.1
	Westbound			E	65.3		D	53.0
	Northbound			D	53.3		C	25.0
	Southbound			F	169.1		C	26.0
3	Seminary Rd / Mark Center Dr	Signal	0.84	C	28.9	1.13	F	101.2
	Eastbound			B	15.8		D	36.3
	Westbound			C	29.8		C	29.6
	Northbound			D	36.5		F	233.9
	Southbound			E	77.1		E	55.1
4	Mark Center Dr / Hilton / CNAC Dr	Stop Sign		B	16.3		F	Err
	Eastbound			A	0.1		A	0.1
	Westbound			A	9.8		A	3.7
	Northbound			F	111.8		F	Err
	Southbound			F	362.1		F	192.9
5	Mark Center Dr / IDA Dr	Signal	0.62	B	10.8	0.58	B	15.2
	Eastbound			A	8.7		A	6.0
	Westbound			B	19.4		B	16.7
	Northbound			B	13.8		B	20.3
	Southbound			B	17.1		B	16.8
6	I-395 SB Off-ramp / Seminary Rd	Signal	0.55	B	10.6	0.54	C	31.3
	Southbound (I-395 SB Off-ramp)			B	17.5		D	54.7
	Westbound			A	4.8		A	6.0
7	I-395 SB On-ramp / Seminary Rd	Signal	0.45	C	30.3	0.97	C	29.6
	Southbound			A	2.8		A	2.5
	Eastbound (I-395 SB On-ramp)			D	40.8		D	39.4
8	I-395 NB Off-ramp / Seminary Rd	Signal	0.68	C	29.7	0.77	D	39.8
	Northbound (I-395 NB Off-ramp)			D	53.2		F	95.3
	Eastbound			A	3.6		A	3.7
9	I-395 NB On-ramp / Seminary Rd	Signal	0.53	B	11.4	0.45	B	11.5
	Northbound			A	1.5		A	2.0
	Westbound (I-395 NB On-ramp)			C	28.3		C	34.3
10	Seminary Rd / Library Ln	Signal	1.00	C	27.9	0.78	C	23.1
	Eastbound			C	34.4		B	13.9
	Westbound			C	20.2		B	18.6
	Northbound			E	72.3		D	41.2
	Southbound			E	76.1		F	123.1

Note: Results are from the HCM module in Synchro.

No.	Intersection Location	Control Type	2013 Baseline AM Peak Hour Condition			2013 Baseline PM Peak Hour Condition		
			V/C	LOS	Delay (sec/veh)	V/C	LOS	Delay (sec/veh)
11	Seminary Rd / George Mason Dr	Signal	0.55	C	34.6	1.05	F	104.3
	Eastbound (Seminary Rd)			C	28.2		F	79.7
	Westbound (Seminary Rd)			D	36.6		E	77.4
	Southbound (S George Mason Dr)			D	43.2		F	175.0
	Northbound (Shopping Plaza)			D	44.1		E	58.3
12	Seminary Rd / Dawes Ave	Signal	0.55	A	6.4	0.75	B	17.0
	Eastbound			A	4.7		B	15.8
	Westbound			A	4.2		B	13.1
	Northbound			E	65.8		D	49.5
	Southbound			E	64.9		E	57.3
13	Seminary Rd / Echols Ave	Signal	0.65	B	11.2	1.03	E	61.9
	Eastbound			B	11.1		B	11.1
	Westbound			A	7.5		F	117.3
	Northbound			E	66.0		E	57.0
	Southbound			E	68.3		E	58.2
14	N. Beauregard St / Fillmore Ave	Signal	0.29	B	11.0	0.35	B	13.2
	Eastbound			E	58.3		D	46.0
	Westbound			E	61.4		D	49.0
	Northbound			A	6.6		B	11.6
	Southbound			A	6.5		A	7.3
15	N. Beauregard St / W Braddock Rd	Signal	0.33	C	34.1	0.5	C	34.8
	Eastbound			E	65.4		D	53.5
	Westbound			E	64.6		E	55.1
	Northbound			B	10.2		C	23.6
	Southbound			C	25.4		C	29.1

Note: Results are from the HCM module in Synchro.

4.3. Transit Services

The projected bus routes that would serve the proposed Mark Center Transit Center at the North parking garage of the BRAC 133 project site are summarized in **Table 7**. The routes summarized include public as well as private transit services to the transit center. The transit service provider for the general public bus routes would include WMATA (Metrobus) and Alexandria Transit Company (DASH) routes. When accessing via Seminary Rd and Mark Center Dr, these routes would be modified slightly to serve the new proposed transit center at the North parking garage by making southbound left turn maneuver along Mark Center Dr at the Mark Center Dr / Hilton / CNAC Dr intersection and rerouting initially towards east of the North parking garage and then reaching the transit center which would be located on the west side of the parking garage. These routes would then egress the project site by traveling

northbound along Mark Center Dr then onto Seminary Rd. US Department of Defense and the existing CNAC and IDA facility would operate private shuttle bus services between Mark Center and the Pentagon Metro Station where the buses would be traveling along Seminary Rd and N. Beauregard Rd to access the site at the new transit center then egress via Mark Center Dr. In addition, private shuttle bus services which would be operated by US Department of Defense between King Metro Station and Mark Center would be traveling along Seminary Rd and Mark Center Dr to access the site at the new transit center then egress via Mark Center Dr. Although the detailed service plans will be determined by transit demand and have not been finalized at this point, it is anticipated that during the peak, the transit center would have anywhere between 15 to 24 buses and shuttles access the site per hour. In addition, according to the I-95/I-395 Transit/TDM Study (February 2008 - Technical Advisory Committee), pertaining to routes serving the study area, the service modifications recommended in the fiscally constrained program included increasing frequency on WMATA 7B by adding one bus (reduce headway from 35 minutes to 17 minutes). Also, in-line Bus Rapid Transit (BRT) station in Lorton and four in-line BRT stations along HOT lane corridor are being proposed, which one of the BRT stations would potentially be located at I-395 interchange with Seminary Rd. Summarized in **Table 8**, also includes some of the other possible routes that would potentially serve the future Mark Center transit center.

Considering the number of buses that will be accessing the new transit center during the peak hour conditions, the impact to the operations at the intersections of Mark Center Dr / Hilton / CNAC Dr and Mark Center Dr / IDA Dr would be expected to be minimal. However, buses intending to make southbound left turn maneuver along Mark Center Dr at the Mark Center Dr / Hilton / CNAC Dr may not find sufficient gap when the opposing through trips egressing from the project site would be heavy along Mark Center Dr especially during PM peak hour conditions. Also, heavy vehicular movement along Mark Center Dr in the vicinity of the unsignalized Mark Center Dr / Hilton / CNAC Dr would make it difficult for the trip to access to and egress from the minor streets.

Table 7: Future Transit Service to the Mark Center Transit Center during Peak Hours

Service Provider	Route	Buses / Hour	Destination	Description	Notes
US DoD	Pentagon to Mark Center	2 to 4 per hour	Pentagon / Mark Center	Travel along I-395 using Seminary and Beauregard to access the site.	DoD has not finalized their TMP and shuttle plan
US DoD	King Street Metro to Mark Center	2 to 4 per hour	King Street Metro / Mark Center	From Seminary, turn left onto Mark Center Drive, and proceed to use road around the transit center.	DoD has not finalized their TMP and shuttle plan
IDA / C.N.A	Pentagon to Mark Center	2 to 4 per hour	Pentagon / Mark Center	Travel along I-395 using Seminary and Beauregard to access the site.	City has asked DoD to work with IDA / C.N.A to combine shuttle operations.
WMATA	7A, F	2 per hour	Pentagon / Landmark	From Southern Towers, continue across Seminary onto Mark Center Drive and proceed to use road around the transit center	Existing route. Minor additional cost with route adjustment.
WMATA	7B,D, E, W, X	4 to 8 per hour	Mark Center / Pentagon	Turn a few of the existing deadhead trips into revenue trips with the starting point being at the Mark Center Transit Center. Service to and from the Pentagon. From Southern Towers, continue across Seminary onto Mark Center Drive and proceed to use road around the transit center.	Need cost information from WMATA. Need to know possible LOS and demand from DoD's TMP and Transit Survey.
DASH	Cross-town	1 to 2 per hour	S. Reynolds St to Potomac Yard	Planned route, route not finalized.	Need cost and a budget for the service, need to decide on exact route.
DASH	AT2	2 per hour	Lincolnia / King Street Metro	Existing service, add stop at the Mark Center Transit Center.	Need additional cost for service.

*Source: Department of Transportation & Environmental Services, City of Alexandria (August 2009)

Table 8: Other Potential Future Transit Service to the Mark Center Transit Center during Peak Hours

Service Provider	Route	Buses / Hour	Destination	Description	Notes
US DoD	Van Dorn to Mark Center	n/a	Mark Center / Van Dorn Metro	Has been talked about in prior discussions.	DoD has not finalized their TMP and shuttle plan.
US DoD	Crystal City to Mark Center	n/a	Crystal City Metro / Mark Center	Route discussed in WMATA BRAC Transit Group.	n/a
WMATA	28B, X	2 per hour	Tysons Corner / Mark Center / King Street Metro	Route under study. Possible starting point for 28X service to Tysons	Need cost and feasibility information from WMATA. Need to know possible LOS from DoD's TMP and Transit Survey.
WMATA	Van Dorn - Pentagon BRT	n/a	Van Dorn / Pentagon	Part of HOT concessions.	HOT project deferred.
WMATA	25A, B, D	2	Ballston / King Street Metro	Existing route	Need cost information from WMATA. Need to know possible LOS from DoD's TMP and Transit Survey.
Unknown	I-95/I-395 Corridor Peak Direction Only	?	Fredericksburg to DC	Part of HOT concessions.	HOT project deferred. Seminary Road has been deferred.
PRTC	PRTC Service area to Mark Center to Pentagon	n/a	PRTC Service area to Mark Center to Pentagon	n/a	Maybe be based on demand and LOS. 12% of 133 employees live in PRTC service area.

*Source: Department of Transportation & Environmental Services, City of Alexandria (August 2009)

5. Future Conditions – 2013 Conceptual Build Alternatives

This section describes the evaluation of the alternative improvement concepts under the 2013 conditions that would effectively accommodate the addition of the project trips at the surrounding roadway network and also minimize the adverse effect to the safety and mobility at the intersections and nearby roadway corridors. The concepts that were evaluated in this study are as follows:

- Concept 1 : 2013 Project volumes with direct access ramp to the BRAC 133 South parking garage
- Concept 2 : 2013 Project volumes with direct access ramp to Mark Center
- Concept 3 : 2013 Project volumes with direct access ramps to the South parking garage and Mark Center
- Concept 4 : 2013 Project volumes with added left turn lane at Seminary Rd / N. Beauregard St intersection along westbound Seminary Rd (triple left) approach and at N. Beauregard St / Mark Center Dr intersection along southbound N. Beauregard St (dual left) approach and without direct access ramps

For each of the Conceptual Alternatives, traffic operational analyses were performed under future 2013 conditions, with the traffic volume projections adjusted according to the geometric or other travel restrictions associated with each concept. The following sections describe the assumptions and the findings associated with the evaluation of each Conceptual Alternative.

5.1. New Ramp to the South Parking Garage (Concept 1)

Conceptual Alternative 1 provides direct ramp connection from I-395 southbound on ramp to the proposed South parking garage located within the BRAC 133 site. This direct ramp would service the authorized vehicles accessing the BRAC 133 site and would divert the project trips that used to travel via Seminary Rd and N. Beauregard St to access and egress from the project site. The layout for Conceptual Alternative 1 is shown in **Figure 6**. Under this concept during the AM peak hour conditions, the heavy left turn demand entering the project site would be reduced notably particularly trips making westbound left turn maneuver along Seminary Rd at Seminary Rd / N. Beauregard St intersection and also southbound left turn trips along N. Beauregard St at N. Beauregard St / Mark Center Dr intersection. During PM peak hour conditions, the heavy right turn demand exiting the project site at the intersection of Seminary Rd / Mark Center Dr would be reduced and diverted to the new direct access ramp.

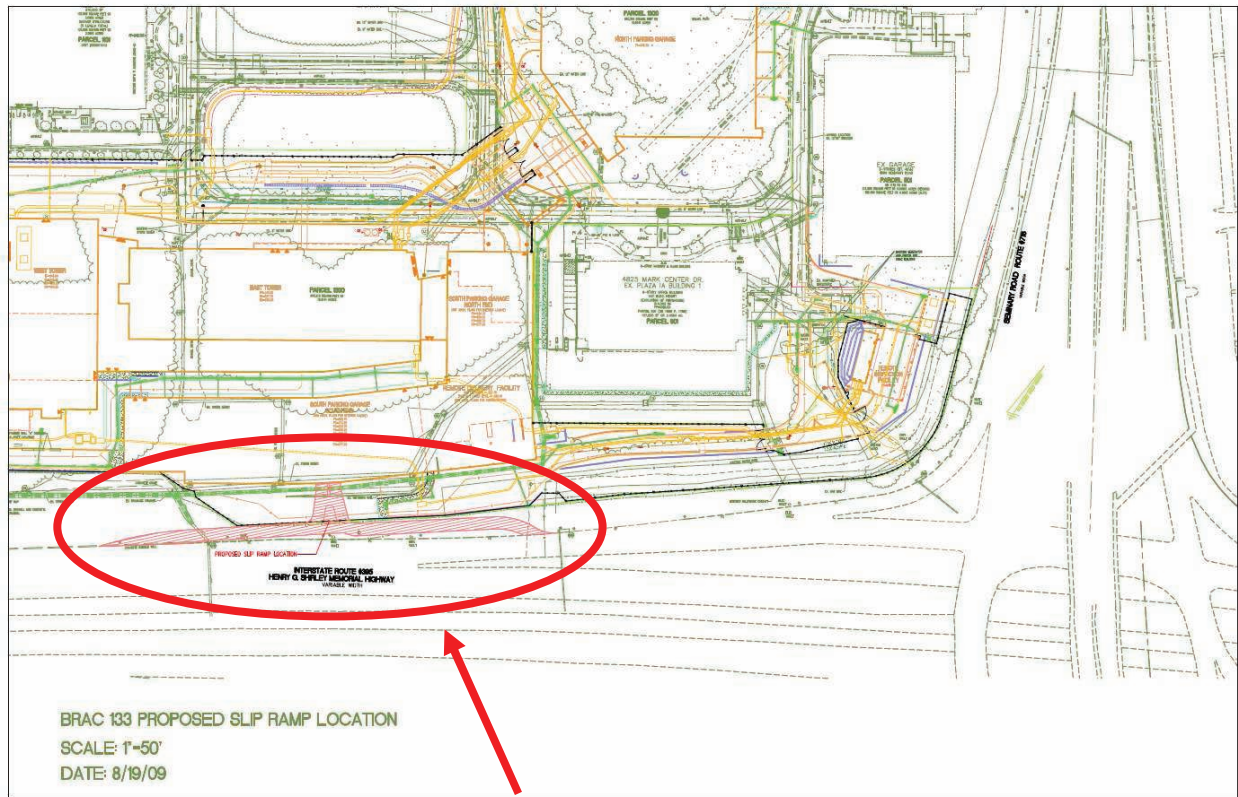


Figure 6: 2013 Conditions with New Ramp to the South Parking Garage (Concept 1) Lay Out

In determining the magnitude of the BRAC 133 project trips being diverted with the addition of the new direct ramps, following assumptions were made based on the origin and destination of the project trips as summarized in Table 9.

Table 9: Assumed Project Trip Diversion with Access to the South Parking Garage

Origin/Destination	Trip Distribution	BRAC 133 Trips to the project site		BRAC 133 Trips from the project site	
		No Diversion	Diversion	No Diversion	Diversion
To/From the North on I-395	20%	2%	18%	20%	0%
To/From the South on I-395	23%	2%	21%	0%	23%
To/From the East on Seminary Rd	20%	15%	5%	20%	0%
To/From the West on Seminary Rd	15%	15%	0%	15%	0%
To/From the North on N. Beauregard St	5%	5%	0%	5%	0%
To/From the South on N. Beauregard St	15%	15%	0%	15%	0%
To/From the North from Southern Towers	2%	2%	0%	2%	0%
Total	100%	56%	44%	77%	23%

The project trips were then reassigned accordingly based on the trip distribution assumption set forth above and the peak hour volumes at the study intersections for Conceptual Alternative 1 are summarized in **Figure 7**.

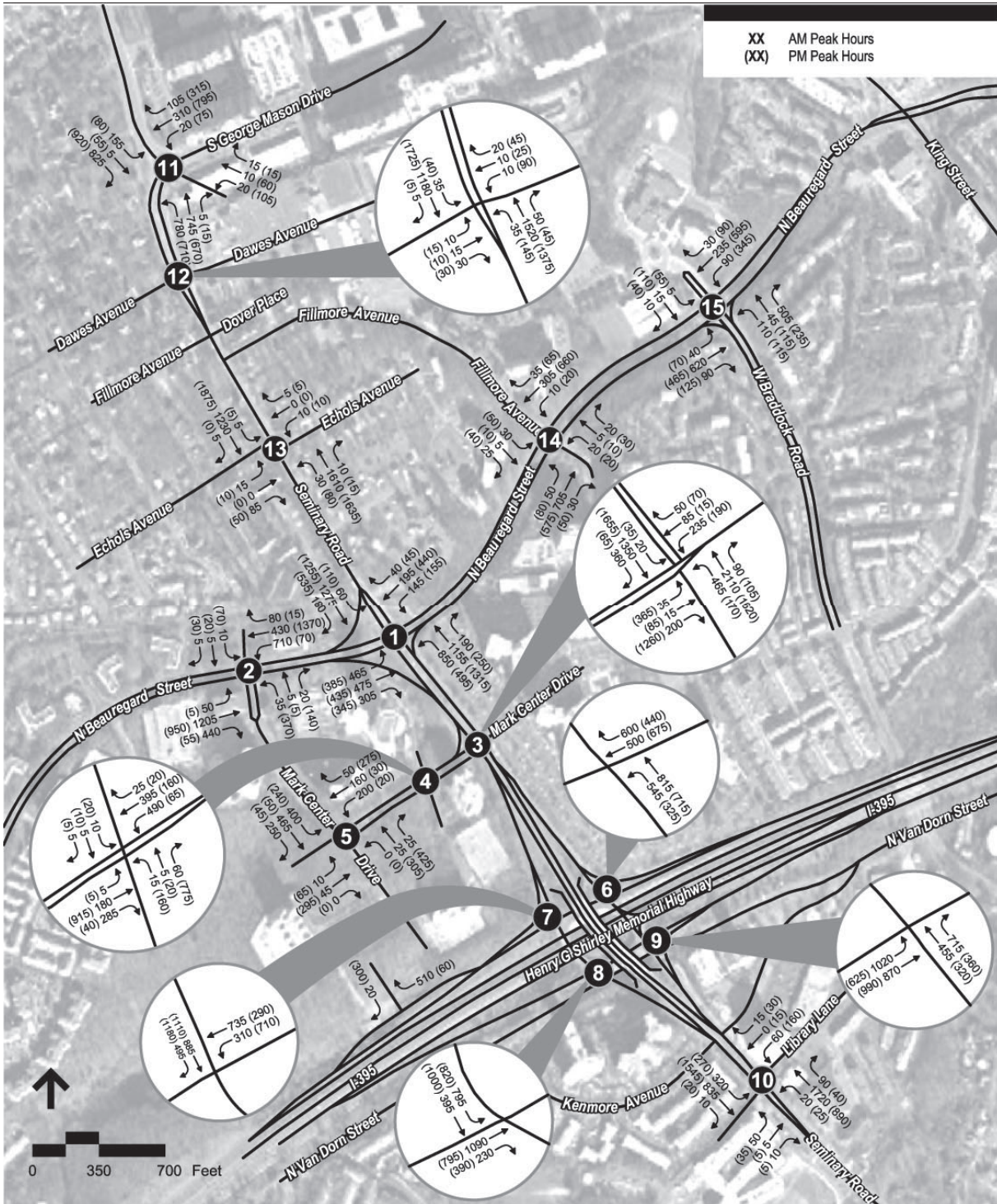


Figure 7: 2013 Conditions with New Ramp to the South Parking Garage Peak Hour Volumes

Table 10 presents the Measures of Effectiveness (MOEs) for the study intersections that would be affected due to the Conceptual Alternative 1 improvement for the year 2013 weekday AM and PM peak hour conditions. The MOE results are for the case with the new direct ramp to the South parking garage without additional left turn lanes along Seminary Rd westbound approach at Seminary Rd/Beauregard St intersection and along N. Beauregard St southbound approach at Beauregard St/Mark Center Dr intersection.

As shown in **Table 10**, operations at Seminary Rd / N. Beauregard St and N. Beauregard St / Mark Center Dr intersections are expected to improve noticeably especially during AM peak hour conditions due to diversion of the project trips to the direct ramp connection as compared to the 2013 baseline conditions presented in **Table 6**. Under the concept, there would be approximately 40% reduction in delay at the intersections of Seminary Rd / N. Beauregard St and approximately 62% reduction in delay N. Beauregard St / Mark Center compared to the 2013 Baseline conditions. Also, LOS F (with delay of 121.3 sec/veh) which would occur for 2013 baseline condition would be improved to LOS E (with delay of 73.4 sec/veh) at Seminary Rd / N. Beauregard St intersection and LOS F (with delay of 109.6 sec/veh) for 2013 baseline condition would be improved to LOS D (with delay of 41.7 sec/veh) at N. Beauregard St / Mark Center Dr intersection. Also, all the rest of the study intersections would be expected to operate at LOS D or better while operations at some of the intersections with the I-395 ramps would slightly deteriorate when compared to the 2013 baseline conditions due to the diversion that will occur for the project trips accessing the site via the new direct ramp.

During PM peak hour conditions, since the project trips destined to get onto I-395 southbound on ramp would likely be using the new direct ramp to egress from the BRAC 133 site, there would be approximately 33% reduction in delay at the intersections of Seminary Rd / Mark Center Dr compared to the 2013 Baseline conditions. Under this concept, LOS F (with delay of 101.2 sec/veh) which would occur for 2013 baseline condition would be improved to LOS E (with delay of 68.0 sec/veh) at this intersection. However, although there would be reduction in delay, the unsignalized Mark Center Dr / Hilton / CNAC Dr intersection would still operate above capacity. The Seminary Rd / George Mason Dr intersection is also expected to continue operating above capacity (LOS F). All of the remaining study intersections would operate at LOS E or better during weekday evening peak hour conditions.

Table 10: 2013 Concept 1 without additional left turn lanes - Intersection MOEs

No.	Intersection Location	Control Type	2013 Concept 1 AM Peak Hour Condition			2013 Concept 1 PM Peak Hour Condition		
			V/C	LOS	Delay (sec/veh)	V/C	LOS	Delay (sec/veh)
1	Seminary Rd / N. Beauregard St	Signal	0.95	E	73.4	0.92	D	45.1
	Eastbound			E	79.6		D	28.3
	Westbound			E	55.7		D	41.5
	Northbound			F	100.4		E	63.6
	Southbound			E	62.5		E	72.7
2	N. Beauregard St / Mark Center Dr	Signal	0.96	D	41.7	0.85	C	29.7
	Eastbound			E	63.2		C	27.1
	Westbound			E	65.3		D	53.0
	Northbound			D	37.9		C	22.9
	Southbound			D	45.5		C	26.3
3	Seminary Rd / Mark Center Dr	Signal	0.78	C	26.4	1.00	E	68.0
	Eastbound			B	14.9		C	28.6
	Westbound			C	25.8		C	32.5
	Northbound			D	39.2		F	150.0
	Southbound			E	75.6		E	55.1
4	Mark Center Dr / Hilton / CNAC Dr	Stop Sign		B	10.3		F	Err
	Eastbound			A	0.1		A	0.1
	Westbound			A	7.7		A	3.3
	Northbound			F	59.0		F	Err
	Southbound			F	168.3		F	110.6
5	Mark Center Dr / IDA Dr	Signal	0.55	A	9.6	0.50	B	14.1
	Eastbound			A	7.1		A	6.2
	Westbound			B	17.3		B	15.7
	Northbound			B	12.6		B	17.5
	Southbound			B	15.2		B	14.7
6	I-395 SB Off-ramp / Seminary Rd	Signal	0.60	C	21.9	0.55	C	32.6
	Southbound (I-395 SB Off-ramp)			D	41.0		E	57.0
	Westbound			A	6.4		A	6.5
7	I-395 SB On-ramp / Seminary Rd	Signal	0.44	C	25.7	0.82	C	27.0
	Southbound			A	3.3		A	2.5
	Eastbound (I-395 SB On-ramp)			D	42.7		D	37.7
8	I-395 NB Off-ramp / Seminary Rd	Signal	0.68	D	39.6	0.77	D	40.0
	Northbound (I-395 NB Off-ramp)			E	71.7		F	95.3
	Eastbound			A	3.8		A	4.0
9	I-395 NB On-ramp / Seminary Rd	Signal	0.56	B	16.6	0.45	B	11.7
	Northbound			A	1.2		A	1.9
	Westbound (I-395 NB On-ramp)			D	41.4		C	34.9
10	Seminary Rd / Library Ln	Signal	1.00	C	27.9	0.78	C	23.1
	Eastbound			C	34.4		B	13.9
	Westbound			C	20.2		B	18.6
	Northbound			E	72.3		D	41.2
	Southbound			E	76.1		F	123.1

Note: Results are from the HCM module in Synchro.

No.	Intersection Location	Control Type	2013 Concept 1 AM Peak Hour Condition			2013 Concept 1 PM Peak Hour Condition		
			V/C	LOS	Delay (sec/veh)	V/C	LOS	Delay (sec/veh)
11	Seminary Rd / George Mason Dr	Signal	0.56	C	34.6	1.05	F	104.3
	Eastbound (Seminary Rd)			C	28.2		F	79.7
	Westbound (Seminary Rd)			D	36.6		E	77.4
	Northbound (Shopping Plaza)			D	43.2		F	175.0
	Southbound (S George Mason Dr)			D	44.1		E	58.3
12	Seminary Rd / Dawes Ave	Signal	0.55	A	5.9	0.75	B	17.0
	Eastbound			A	4.7		B	15.8
	Westbound			A	3.3		B	13.1
	Northbound			E	65.8		D	49.5
	Southbound			E	64.9		E	57.3
13	Seminary Rd / Echols Ave	Signal	0.65	B	11.5	1.03	E	61.8
	Eastbound			B	11.1		B	11.1
	Westbound			A	8.1		F	117.2
	Northbound			E	66.0		E	57.0
	Southbound			E	68.3		E	58.2
14	N. Beauregard St / Fillmore Ave	Signal	0.29	B	10.8	0.35	B	13.1
	Eastbound			E	58.3		D	46.0
	Westbound			E	61.4		D	49.0
	Northbound			A	6.1		B	11.6
	Southbound			A	6.5		A	7.3
15	N. Beauregard St / W Braddock Rd	Signal	0.33	C	34.3	0.5	C	34.8
	Eastbound			E	65.4		D	53.5
	Westbound			E	64.6		E	55.1
	Northbound			B	10.7		C	23.5
	Southbound			C	25.4		C	29.1

Note: Results are from the HCM module in Synchro.

The MOE results for the case with a new direct ramp to the South parking garage along with the additional left turn lanes at Seminary Rd/Beauregard St and Beauregard St/Mark Center Dr intersections for the year 2013 weekday AM peak hour conditions are presented in **Table 11**. The only difference with the MOE results summarized in **Table 10** and **Table 11** is whether an additional third and second left turn lanes are provided at Seminary Rd/Beauregard St intersection for Seminary Rd westbound approach and for N.Beauregard St southbound approach at N.Beauregard St/Mark Center Dr intersection, respectively. Therefore, **Table 11** only includes a comparison at these two intersections where the MOEs would be different.

Table 11: 2013 AM Concept 1 without and with additional left turn lanes - Key Intersection MOEs

No.	Intersection Location	Control Type	Without Additional Left Turn Lanes AM Peak Hour Condition			With Additional Left Turn Lanes AM Peak Hour Condition		
			V/C	LOS	Delay (sec/veh)	V/C	LOS	Delay (sec/veh)
1	Seminary Rd / N. Beauregard St	Signal	0.95	E	73.4	0.83	D	52.3
	Eastbound			E	79.6		D	53.9
	Westbound			E	55.7		D	45.2
	Northbound			F	100.4		E	59.2
	Southbound			E	62.5		E	64.3
2	N. Beauregard St / Mark Center Dr	Signal	0.96	D	41.7	0.66	C	24.7
	Eastbound			E	63.2		E	62.7
	Westbound			E	65.3		E	64.7
	Northbound			D	37.9		C	23.5
	Southbound			D	45.5		C	23.8

With the additional left turn lanes at Seminary Rd / Beauregard St and N.Beauregard St / Mark Center Dr intersections, the overall delay would decrease at the two intersections and the LOS would improve by one letter grade because the addition of a left-turn lane would provide additional capacity for the heavy left-turn demand volume at these intersections. For this comparison, MOEs results are only summarized for AM peak hour conditions since this is the time period serving the highest left turn project trip demand due to the project trips entering the project site at these intersections compared to the PM peak hour conditions. During PM peak hour conditions, even with no additional left turn lane provided for westbound Seminary Rd at Seminary Rd / N. Beauregard St intersection, the intersection would operate under capacity with LOS D and the delay would not differ significantly with the 2013 baseline conditions.

The following is a summary of the key benefits and disadvantages of Conceptual Alternative 1:

- Benefits
 - By diverting the project trips via direct access ramp, operations during AM peak hour conditions at Seminary Rd / N. Beauregard St and N. Beauregard St / Mark Center Dr intersections serving the project site would be improved.
 - By providing additional egress via direct access ramp, operations during PM peak hour conditions at Seminary Rd / Mark Center Dr would be improved.
 - Does not require any major reconfiguration of the geometry along existing roadways except at the new access ramp.

- Disadvantages
 - Involves some ROW impacts, including undergoing a rigorous interchange modification procedure for constructing the new access ramp.
 - Depending on the processing time required to clear the vehicles at the security check point at the entrance to the south parking garage, there is a possibility of vehicle spill back, which would affect the operations along the I-395 southbound on ramp and the Seminary Rd eastbound approach.
 - Weaving maneuvers between the vehicles accessing the new direct ramp and the I-395 southbound on ramp traffic would cause some turbulence in the traffic flow.
 - Driver way finding could be confusing to traffic that is re-routed to the new direct access ramps. Rerouting could increase driver confusion due to multiple turn movements over a short distance.

5.2. New Ramp to Mark Center (Concept 2)

Conceptual Alternative 2 provides a direct ramp connection from I-395 southbound on ramp to the existing internal circulation roadways within Mark Center. This direct ramp would service not only the authorized vehicles accessing the BRAC 133 site but also the existing and potential future tenants of other buildings located within Mark Center. Therefore under Concept 2, it is anticipated that there would be more diversion of trips to the direct ramp connection which used to travel via Seminary Rd and N. Beauregard St in order to access and egress the project site. The layout for Conceptual Alternative 2 is shown in **Figure 8**.

During the AM peak hour conditions, the heavy left turn demand entering the project site for the westbound Seminary Rd at Seminary Rd / N. Beauregard St intersection and southbound N. Beauregard St at N. Beauregard St / Mark Center Dr intersection would be further reduced than what would occur under Concept 1 due to the additional diversion of trips anticipated by the existing and future Mark Center tenants. Also, during PM peak hour conditions, the heavy right turn demand exiting the project site at the intersection of Seminary Rd / Mark Center Dr would be further reduced and diverted to the new direct access ramp.

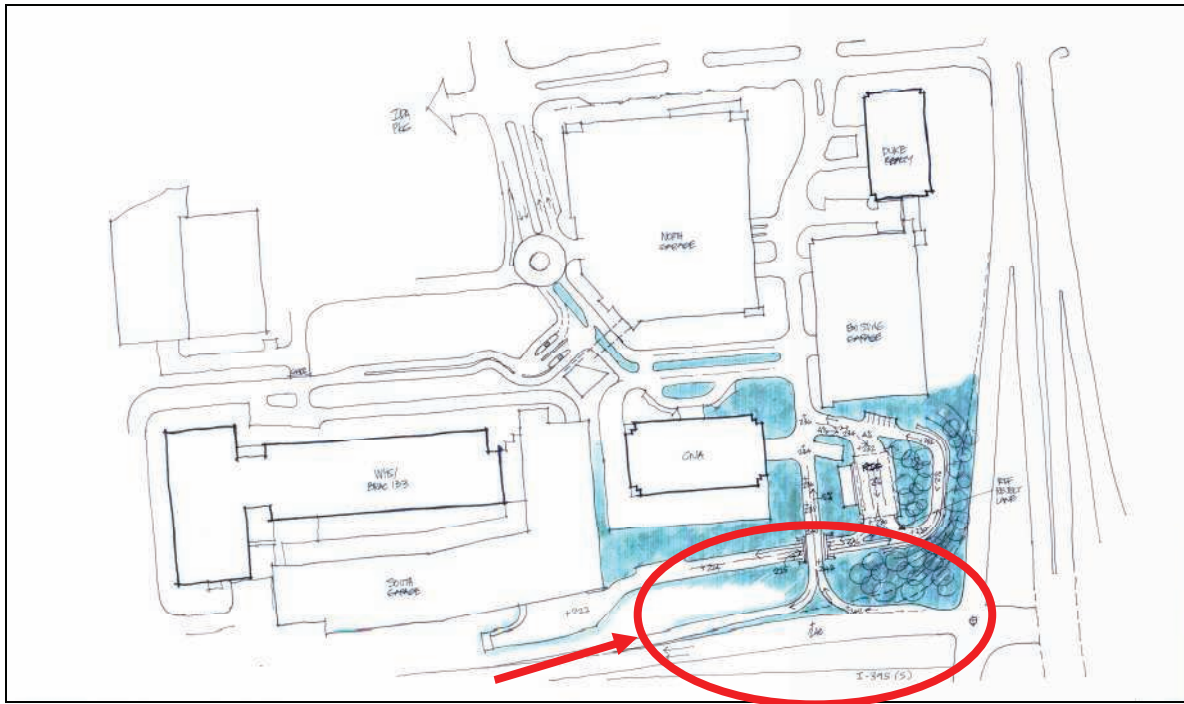


Figure 8: 2013 Conditions with New Ramp to Mark Center (Concept 2) Lay Out

In determining the magnitude of the BRAC 133 project trips that would be diverting with the addition of the new direct ramps, similar assumptions were made as that of Concept 1 based on the origin and destination of the project trips as summarized in **Table 9**. However, for Concept 2 additional diversion was assumed for the trips made by the existing and potential future tenants as summarized in **Table 12** that are likely to change their previous travel route and access/egress via the new direct ramp.

Table 12: Assumed Trip Diversion for Other Tenants with Access to Mark Center under Concept 2

Origin/Destination	Mark Center Trips to the project site		Mark Center Trips from the project site	
	No Diversion	Diversion to New Ramp	No Diversion	Diversion from New Ramp
To/From the North on I-395	10%	90%	100%	0%
To/From the South on I-395	11%	89%	0%	100%
To/From the East on Seminary Rd	85%	15%	100%	0%

The project trips were then reassigned accordingly based on the trip distribution assumption set forth above and the peak hour volumes at the study intersections for Conceptual Alternative 2 are summarized in **Figure 9**.

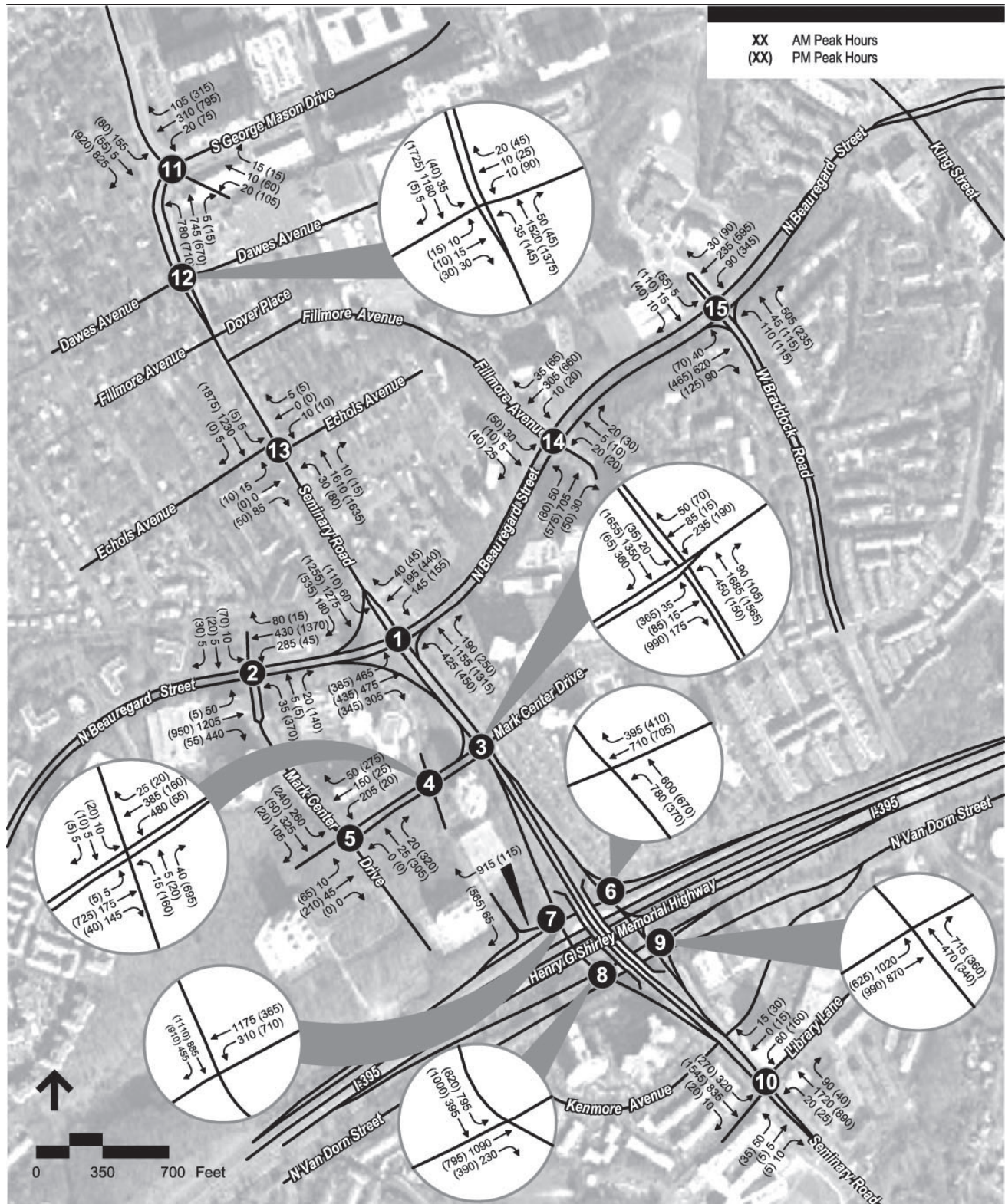


Figure 9: 2013 Conditions with New Ramp to Mark Center (Concept 2) Peak Hour Volumes

Using the established peak hour volumes for Concept 2, operational analysis was performed and **Table 10** presents the Measures of Effectiveness (MOEs) for the intersections that would be affected due to the Conceptual Alternative 2 improvement for the year 2013 AM and PM peak hour conditions. The MOE results are for the case with a new direct ramp to the Mark Center only and without additional left turn lanes at Seminary Rd / Beauregard St and Beauregard St / Mark Center Dr intersections.

As shown in **Table 13**, operations at Seminary Rd / N. Beauregard St and N. Beauregard St / Mark Center Dr intersections are expected to improve noticeably especially during AM peak hour conditions due to the further increase in diversion of the BRAC 133 project trips and Mark Center trips accessing Mark Center via the direct access ramp. At these intersections which serve as the primary access points to the project site, the overall reduction in delay would be approximately 60% at the intersections of Seminary Rd / N. Beauregard St and approximately 84% reduction in delay at N. Beauregard St / Mark Center compared to the 2013 Baseline conditions. With Concept 2, LOS F (with delay of 121.3 sec/veh) which would occur for 2013 baseline condition would be improved to LOS D (with delay of 47.9 sec/veh) at Seminary Rd / N. Beauregard St intersection and LOS F (with delay of 109.6 sec/veh) for 2013 baseline condition would be improved to LOS B (with delay of 17.5 sec/veh) at N. Beauregard St / Mark Center intersection. Also, all the rest of the study intersection would be expected to operate at LOS D or better while operations at some of the intersections with the I-395 ramps would slightly deteriorate when compared to the 2013 Baseline and Concept 1 conditions due to the heavier diversion that would occur for the project trips accessing Mark Center via new direct ramp.

During PM peak hour conditions, since the project trips destined to I-395 southbound on ramp would likely be using the new direct ramp to egress from Mark Center, operations at Seminary Rd / Mark Center Dr intersection which would serve as main egress point are expected to further improve. The overall reduction in delay would be approximately 54% at this intersection and LOS F (with delay of 101.2 sec/veh) which would occur for 2013 baseline condition would be improved to LOS D (with delay of 46.2 sec/veh) at Seminary Rd / Mark Center intersection under this concept. There would also be significant reduction in delay at the unsignalized Mark Center Dr / Hilton / CNAC Dr intersection although this intersection would still operate above capacity. The Seminary Rd / George Mason Dr intersection is also expected to continue operating above capacity (LOS F). All of the remaining study intersections would operate at LOS E or better during PM peak hour conditions.

Table 13: 2013 Concept 2 without additional left turn lanes - Intersection MOEs

No.	Intersection Location	Control Type	2013 Concept 2 AM Peak Hour Condition			2013 Concept 2 PM Peak Hour Condition		
			V/C	LOS	Delay (sec/veh)	V/C	LOS	Delay (sec/veh)
1	Seminary Rd / N. Beauregard St	Signal	0.78	D	47.9	0.87	D	44.9
	Eastbound			D	43.0		C	27.8
	Westbound			D	39.9		D	43.4
	Northbound			E	62.8		E	64.3
	Southbound			E	55.4		E	64.7
2	N. Beauregard St / Mark Center Dr	Signal	0.69	B	17.5	0.85	C	27.6
	Eastbound			E	63.2		C	26.0
	Westbound			E	65.3		D	47.9
	Northbound			B	13.8		C	23.5
	Southbound			C	20.7		C	23.3
3	Seminary Rd / Mark Center Dr	Signal	0.77	C	25.7	0.91	D	46.2
	Eastbound			B	14.6		C	24.2
	Westbound			C	24.2		D	35.7
	Northbound			D	43.0		F	84.5
	Southbound			E	75.6		E	55.1
4	Mark Center Dr / Hilton / CNAC Dr	Stop Sign		A	8.5		F	Err
	Eastbound			A	0.1		A	0.1
	Westbound			A	6.5		A	2.6
	Northbound			E	48.9		F	Err
	Southbound			F	108.6		F	50.5
5	Mark Center Dr / IDA Dr	Signal	0.45	A	9.2	0.41	B	12.2
	Eastbound			A	6.4		A	5.4
	Westbound			B	15.0		B	13.6
	Northbound			B	10.9		B	14.9
	Southbound			B	13.1		B	13.6
6	I-395 SB Off-ramp / Seminary Rd	Signal	0.68	D	36.2	0.56	D	39.7
	Southbound (I-395 SB Off-ramp)			E	69.7		E	71.4
	Westbound			A	9.4		A	5.7
7	I-395 SB On-ramp / Seminary Rd	Signal	0.60	D	38.0	0.52	D	54.9
	Southbound			A	6.5		A	2.8
	Eastbound (I-395 SB On-ramp)			E	72.9		E	76.2
8	I-395 NB Off-ramp / Seminary Rd	Signal	0.68	D	49.2	0.77	D	46.5
	Northbound (I-395 NB Off-ramp)			F	90.2		F	112.1
	Eastbound			A	3.8		A	3.8
9	I-395 NB On-ramp / Seminary Rd	Signal	0.55	C	20.7	0.46	B	12.8
	Northbound			A	0.9		A	1.9
	Westbound (I-395 NB On-ramp)			D	52.3		D	37.8
10	Seminary Rd / Library Ln	Signal	1.00	C	27.9	0.78	C	23.1
	Eastbound			C	34.4		B	13.9
	Westbound			C	20.2		B	18.6
	Northbound			E	72.3		D	41.2
	Southbound			E	76.1		F	123.1

Note: Results are from the HCM module in Synchro.

No.	Intersection Location	Control Type	2013 Concept 2 AM Peak Hour Condition			2013 Concept 2 PM Peak Hour Condition		
			V/C	LOS	Delay (sec/veh)	V/C	LOS	Delay (sec/veh)
11	Seminary Rd / George Mason Dr	Signal	0.55	C	34.6	1.05	F	104.3
	Eastbound (Seminary Rd)			C	28.2		F	79.7
	Westbound (Seminary Rd)			D	36.6		E	77.4
	Northbound (Shopping Plaza)			D	43.2		F	175.0
	Southbound (S George Mason Dr)			D	44.1		E	58.3
12	Seminary Rd / Dawes Ave	Signal	0.55	A	5.8	0.75	B	17.0
	Eastbound			A	4.7		B	15.8
	Westbound			A	3.1		B	13.1
	Northbound			E	65.8		D	49.5
	Southbound			E	64.9		E	57.3
13	Seminary Rd / Echols Ave	Signal	0.65	B	11.8	1.03	E	62.9
	Eastbound			A	9.6		B	11.1
	Westbound			A	7.9		F	119.4
	Northbound			E	66.0		E	57.0
	Southbound			E	68.3		E	58.2
14	N. Beauregard St / Fillmore Ave	Signal	0.29	B	11.8	0.35	B	12.8
	Eastbound			E	58.3		D	46.0
	Westbound			E	61.4		D	49.0
	Northbound			A	7.8		B	10.9
	Southbound			A	6.5		A	7.3
15	N. Beauregard St / W Braddock Rd	Signal	0.33	C	35.0	0.5	C	34.8
	Eastbound			E	65.4		D	53.5
	Westbound			E	64.6		E	55.1
	Northbound			B	12.3		C	23.8
	Southbound			C	25.4		C	29.1

Note: Results are from the HCM module in Synchro.

The MOE results for the case with a new direct ramp to Mark Center along with the additional left turn lanes at Seminary Rd / Beauregard St and Beauregard St / Mark Center Dr intersections for the year 2013 weekday AM peak hour conditions are presented in **Table 14**. With the additional left turn lanes at Seminary Rd / Beauregard St and N.Beauregard St / Mark Center Dr intersections, the overall delay would slightly decrease at the two intersections. However, the reduction in delay is not as noticeable as with Concept 1 because the left turn capacity is sufficient to accommodate the left turn demand volume at these intersections. AM peak hour results are only summarized for the similar reason as stated for Concept 1.

Table 14: 2013 AM Concept 2 without and with additional left turn lanes - Key Intersection MOEs

No.	Intersection Location	Control Type	Without Additional Left Turn Lanes AM Peak Hour Condition			With Additional Left Turn Lanes AM Peak Hour Condition		
			V/C	LOS	Delay (sec/veh)	V/C	LOS	Delay (sec/veh)
1	Seminary Rd / N. Beauregard St	Signal	0.78	D	47.9	0.72	D	42.5
	Eastbound			D	43.0		D	38.4
	Westbound			D	39.9		D	38.8
	Northbound			E	62.8		D	48.5
	Southbound			E	55.4		E	55.9
2	N. Beauregard St / Mark Center Dr	Signal	0.69	B	17.5	0.52	B	16.5
	Eastbound			E	63.2		E	63.2
	Westbound			E	65.3		E	65.3
	Northbound			B	13.8		B	12.1
	Southbound			C	20.7		C	21.0

Note: Results are from the HCM module in Synchro.

Under Concept 2, due to the diversion of traffic to the new direct access ramp, overall intersection vehicular delay is anticipated to decrease during all time periods but the most notable delay reduction would be expected during the AM peak hour conditions at the key study intersections functioning as access/egress to the site, compared to 2013 Baseline and Concept 1 conditions. The operational improvements demonstrated are due to the increase in capacity associated with the new access ramp. Also, anticipated delay at the other study intersections would not change significantly where it would continue to operate acceptably. However, although still maintaining LOS D, the operations at some of the intersections with the I-395 ramps would slightly deteriorate when compared to the 2013 Baseline and Concept 1 conditions due to the heavier diversion that would occur for the project trips accessing Mark Center via the new direct ramp.

Overall, the benefits under this concept would be significant as compared to the other conceptual alternatives. However, the benefits obtainable under this concept also require relatively high construction costs and would have both positive and negative impacts associated with these extensive improvements.

The following is a summary of the key benefits and disadvantages of Conceptual Alternatives 2:

- Benefits
 - Further improves the operations during AM peak hour conditions than 2013 Concept 1 at the key intersections serving the project site which are the intersections at Seminary Rd / N. Beauregard St and N. Beauregard St / Mark Center Dr. Diverting not only the BRAC 133 project trips but also trips made by the existing and future Mark Center tenants via the new direct ramp would result in further operational improvement.
 - Further improves operations compared to 2013 Baseline Concept 1 conditions at Seminary Rd / Mark Center Dr during PM peak hour conditions by additional egressing the project site via direct access ramp.
- Disadvantages
 - Entails significant ROW impacts at the new access ramp, including undergoing an interchange modification process.
 - Major construction efforts would be required due to grade separating the access ramp under tight spacing requirements.
 - Current geometry of the I-395 southbound on ramp would have to be reconfigured and the free right turn channelized ramp would need to be removed and dual right turns will be added, which would deteriorate the operations at this intersection.
 - Weaving distance between the new ramp and the I-395 southbound on ramp intersection would be fairly short (approximately 200 feet) and turbulence would occur due to the weaving maneuver.
 - Heavy diverted trips accessing/egressing via the direct ramp may cause congestion and deteriorate the operations of the Mark Center internal circulation roadways.
 - Depending on the level of congestion of the internal circulation roadway, there is possibility of vehicle spill back that would affect the traffic flow along the I-395 southbound on ramps and potentially impact the operations along I-395 southbound ramps as well as the Seminary Rd eastbound approach.
 - Driver wayfinding could be confusing to traffic that is re-routed to the new direct access ramps. Rerouting could increase driver confusion due to multiple turn movements over a short distance.
 - Possibility of cut through traffic not destined to Mark Center accessing this direct access ramp therefore increasing congestion along the internal circulation roadways.

5.3. New Ramp to the South Garage and Mark Center (Concept 3)

Conceptual Alternative 3 is a concept which combines Conceptual Alternatives 1 and 2 where the proposed direct ramp connection from I-395 southbound on ramp will be provided to the BRAC 133 South parking garage as well as to the existing internal circulation roads within Mark Center. Therefore, there would be two separate direct ramps which one would service the authorized vehicles accessing the BRAC 133 site while another would serve the existing and potential future tenants of other buildings located within Mark Center.

In determining the magnitude of the BRAC 133 project trips that would be diverting with the addition of the two new direct ramps, similar assumptions were made as that of Concept 1 and 2 based on the origin and destination of the project trips as summarized in **Table 9**. Under Concept 3, additional diversion was assumed for the trips made by the existing and potential future tenants as summarized in **Table 15** that are likely to change their previous travel route and access/egress the project site via new direct ramp. Compared to diversion anticipated under Concept 2, it was assumed that there would be slightly higher diversion for the trips made by the existing and potential future tenants since more capacity will be available to the direct ramp serving the Mark Center with the BRAC 133 trips being serviced via separate direct ramp connections.

Table 15: Assumed Trip Diversion for Other Tenants with Access to Mark Center under Concept 3

Origin/Destination	Mark Center Trips to the project site		Mark Center Trips from the project site	
	No Diversion	Diversion to New Ramp	No Diversion	Diversion from New Ramp
To/From the North on I-395	5%	95%	100%	0%
To/From the South on I-395	6%	94%	0%	100%
To/From the East on Seminary Rd	80%	20%	100%	0%

The project trips were then reassigned accordingly based on the trip distribution assumption set forth above and the peak hour volumes at the study intersections for Conceptual Alternative 2 are summarized in **Figure 10**.

Using the established peak hour volumes for Concept 3, operational analysis was performed and **Table 16** presents the Measures of Effectiveness (MOEs) for the study intersections that would be affected due to the Conceptual Alternative 3 improvement for the year 2013 AM and PM peak hour conditions. The MOE results are for cases with new direct ramps and without additional left turn lanes at Seminary Rd / Beauregard St and Beauregard St / Mark Center Dr intersections.

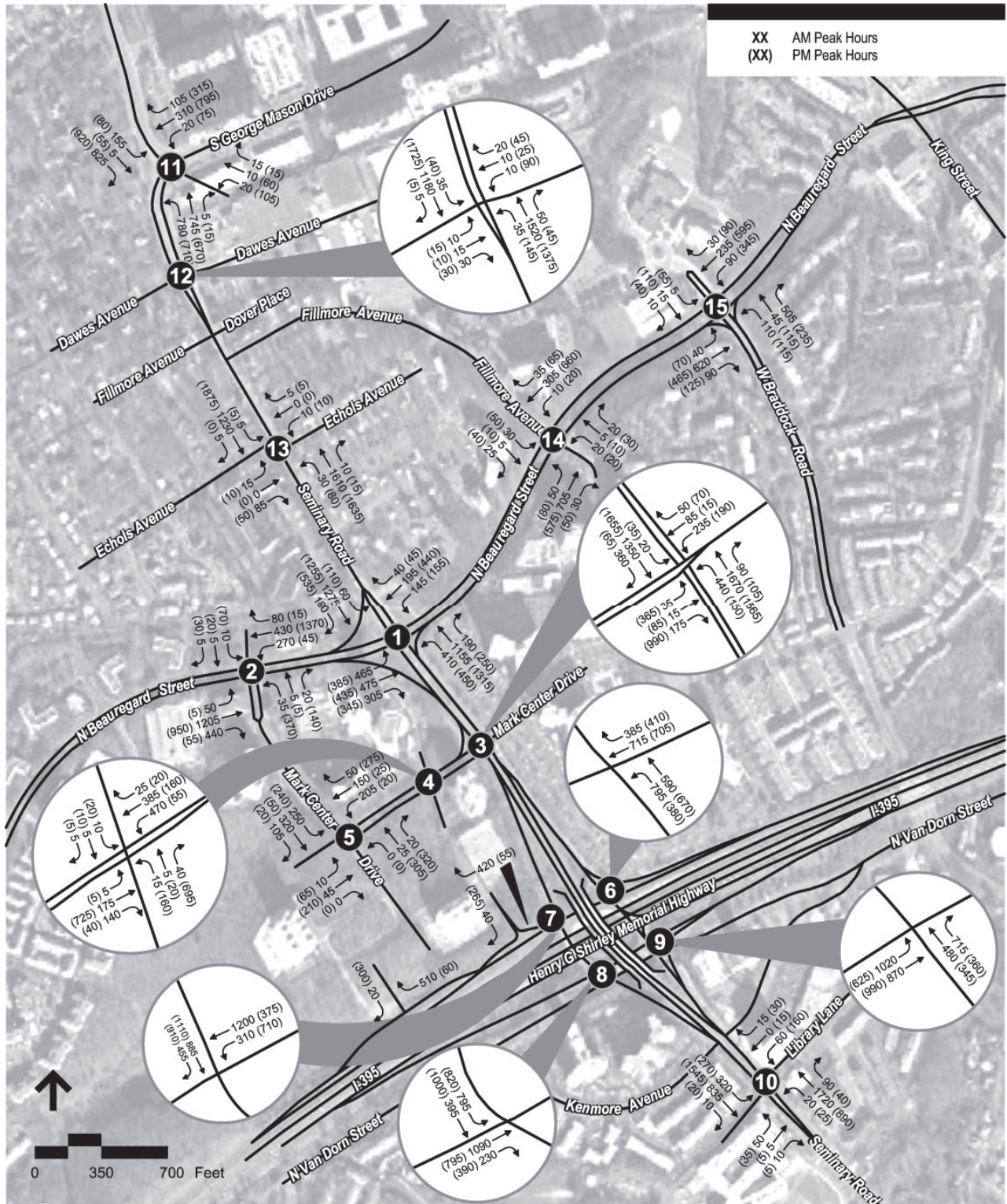


Figure 10: 2013 Conditions with New Ramps to the South Garage and Mark Center Peak Hour Volumes

Table 16: 2013 Concept 3 without Additional left turn lanes - Intersection MOEs

No.	Intersection Location	Control Type	2013 Concept 3 AM Peak Hour Condition			2013 Concept 3 PM Peak Hour Condition		
			V/C	LOS	Delay (sec/veh)	V/C	LOS	Delay (sec/veh)
1	Seminary Rd / N. Beauregard St	Signal	0.78	D	47.7	0.9	D	43.0
	Eastbound			D	43.9		C	27.7
	Westbound			D	39.4		D	38.2
	Northbound			E	61.5		E	62.2
	Southbound			E	55.6		E	68.7
2	N. Beauregard St / Mark Center Dr	Signal	0.67	B	16.8	0.85	C	27.7
	Eastbound			E	63.2		C	26.0
	Westbound			E	65.3		D	47.9
	Northbound			B	13.1		C	23.5
	Southbound			C	19.8		C	23.6
3	Seminary Rd / Mark Center Dr	Signal	0.76	C	25.5	0.91	D	46.2
	Eastbound			B	14.4		C	24.4
	Westbound			C	24.0		D	35.7
	Northbound			D	43.3		F	84.5
	Southbound			E	75.6		E	55.1
4	Mark Center Dr / Hilton / CNAC Dr	Stop Sign		A	8.1		F	Err
	Eastbound			A	0.1		A	0.1
	Westbound			A	6.4		A	2.6
	Northbound			E	45.4		F	Err
	Southbound			F	100.7		F	50.5
5	Mark Center Dr / IDA Dr	Signal	0.44	A	9.2	0.41	B	12.2
	Eastbound			A	6.3		A	5.4
	Westbound			B	14.8		B	13.6
	Northbound			B	10.9		B	14.9
	Southbound			B	13.1		B	13.6
6	I-395 SB Off-ramp / Seminary Rd	Signal	0.68	D	37.1	0.57	D	39.5
	Southbound (I-395 SB Off-ramp)			E	71.9		E	71.4
	Westbound			A	9.5		A	5.7
7	I-395 SB On-ramp / Seminary Rd	Signal	0.61	D	37.8	0.52	D	50.6
	Southbound			A	6.7		A	2.9
	Eastbound (I-395 SB On-ramp)			E	72.9		E	76.2
8	I-395 NB Off-ramp / Seminary Rd	Signal	0.68	D	49.2	0.77	D	46.6
	Northbound (I-395 NB Off-ramp)			F	90.2		F	112.1
	Eastbound			A	3.8		A	3.9
9	I-395 NB On-ramp / Seminary Rd	Signal	0.56	C	22.2	0.46	B	13.1
	Northbound			A	0.9		A	1.9
	Westbound (I-395 NB On-ramp)			D	55.8		D	38.6
10	Seminary Rd / Library Ln	Signal	1.00	C	27.9	0.78	C	23.1
	Eastbound			C	34.4		B	13.9
	Westbound			C	20.2		B	18.6
	Northbound			E	72.3		D	41.2
	Southbound			E	76.1		F	123.1

Note: Results are from the HCM module in Synchro.

No.	Intersection Location	Control Type	2013 Concept 3 AM Peak Hour Condition			2013 Concept 3 PM Peak Hour Condition		
			V/C	LOS	V/C (sec/veh)	V/C	LOS	V/C (sec/veh)
11	Seminary Rd / George Mason Dr	Signal	0.55	C	34.6	1.05	F	104.3
	Eastbound (Seminary Rd)			C	28.2		F	79.7
	Westbound (Seminary Rd)			D	36.6		E	77.4
	Northbound (Shopping Plaza)			D	43.2		F	175.0
	Southbound (S George Mason Dr)			D	44.1		E	58.3
12	Seminary Rd / Dawes Ave	Signal	0.55	A	5.9	0.75	B	17.0
	Eastbound			A	4.7		B	15.8
	Westbound			A	3.2		B	13.1
	Northbound			E	65.8		D	49.5
	Southbound			E	64.9		E	57.3
13	Seminary Rd / Echols Ave	Signal	0.65	B	11.7	1.03	E	62.4
	Eastbound			A	9.6		B	11.1
	Westbound			A	9.6		F	118.5
	Northbound			E	66.0		E	57.0
	Southbound			E	68.3		E	58.2
14	N. Beauregard St / Fillmore Ave	Signal	0.29	B	11.5	0.35	B	12.9
	Eastbound			E	58.3		D	46.0
	Westbound			E	61.4		D	49.0
	Northbound			A	7.4		B	11.1
	Southbound			A	6.5		A	7.3
15	N. Beauregard St / W Braddock Rd	Signal	0.33	C	35.0	0.5	C	34.8
	Eastbound			E	65.4		D	53.5
	Westbound			E	64.6		E	55.1
	Northbound			B	12.3		C	23.8
	Southbound			C	25.4		C	29.1

Note: Results are from the HCM module in Synchro.

As shown in **Table 16**, operations at Seminary Rd / N. Beauregard St and N. Beauregard St / Mark Center Dr intersections are expected to improve noticeably especially during AM peak hour condition, due to further increase in diversion of the BRAC 133 project trips and Mark Center trips via two new direct ramp connections to Mark Center. At these intersections which serve as the primary access points to the project site, the overall reduction in delay would be fairly similar as that under Concept 2, with approximately 61% at the intersections of Seminary Rd / N. Beauregard St and approximately 85% reduction in delay at N. Beauregard St / Mark Center compared to the 2013 Baseline conditions. With Concept 3, LOS F (with delay of 121.3 sec/veh) which would occur for 2013 baseline condition would be improved to LOS D (with delay of 47.7 sec/veh) at Seminary Rd / N. Beauregard St intersection and LOS F (with delay of 109.6 sec/veh) for 2013 baseline condition would be improved to LOS B (with delay of 16.8 sec/veh) at N. Beauregard St / Mark Center intersection. Also, all the rest of the study intersection would be expected to operate at LOS D or better while operations at some of the intersections with the

I-395 ramps would slightly deteriorate when compared to the 2013 Baseline and Concept 1 conditions due to the heavier diversion that would occur for the project trips accessing Mark Center via new direct ramp.

During evening peak hour conditions, since the project trips destined to I-395 southbound on ramp would likely be using the two new direct ramps to egress from Mark Center, operations at Seminary Rd / Mark Center Dr intersection which would serve as main egress point are expected to further improve. The overall reduction in delay would be approximately 54% at this intersection and LOS F (with delay of 101.2 sec/veh) which would occur for 2013 baseline condition would be improved to LOS D (with delay of 46.2 sec/veh) at Seminary Rd / Mark Center intersection under this concept. There would be significant reduction in delay at the unsignalized Mark Center Dr / Hilton / CNAC Dr intersection although this intersection would still operate above capacity. The Seminary Rd / George Mason Dr intersection is also expected to continue operating above capacity (LOS F). All of the remaining study intersections would operate at LOS E or better during PM peak hour conditions.

The MOE results for case with the two new direct ramp connections to Mark Center along with the additional left turn lanes at Seminary Rd/Beauregard St and Beauregard St/Mark Center Dr intersections for the year 2013 weekday AM peak hour conditions are presented in **Table 17**.

Table 17: 2013 AM Concept 3 without and with Additional left turn lanes - Key Intersection MOEs

No.	Intersection Location	Control Type	Without Additional Left Turn Lanes AM Peak Hour Condition			With Additional Left Turn Lanes AM Peak Hour Condition		
			V/C	LOS	Delay (sec/veh)	V/C	LOS	Delay (sec/veh)
1	Seminary Rd / N. Beauregard St	Signal	0.78	D	47.7	0.72	D	42.4
	Eastbound			D	43.9		D	37.5
	Westbound			D	39.4		D	39.4
	Northbound			E	61.5		D	48.7
	Southbound			E	55.6		E	54.6
2	N. Beauregard St / Mark Center Dr	Signal	0.67	B	16.8	0.51	B	16.2
	Eastbound			E	63.2		E	63.2
	Westbound			E	65.3		E	65.3
	Northbound			B	13.1		B	11.8
	Southbound			C	19.8		C	20.9

Note: Results are from the HCM module in Synchro.

With the additional left turn lanes at Seminary Rd/Beauregard St and N.Beauregard St/Mark Center Dr intersections, similar to Concept 2 conditions, the overall delay would only slightly decrease at the two intersections and the reduction in delay is not as noticeable as Concept 1 because the left turn capacity is sufficient to accommodate the left turn demand volume at these intersections. AM peak hour results are only summarized for the similar reason as stated for Concept 1.

Under Concept 3, due to the diversion of traffic to the two new direct access ramps, overall intersection vehicular delay is anticipated to decrease during all time periods at a similar level as that under Concept 2. The most notable delay reduction would be expected during the AM peak hour conditions at the key study intersections functioning as access/egress to the site, compared to 2013 Baseline and Concept 1 conditions. The operational improvements demonstrated are due to the increase in capacity associated with the two new access ramps. Also, anticipated delay at the other study intersections would not change significantly after the improvements for any time periods where it would continue to operate acceptably. However, although still maintaining, LOS D, the operations at some of the intersections with the I-395 ramps would slightly deteriorate when compared to the 2013 Baseline and Concept 1 conditions due to the heavier diversion that would occur for the project trips accessing Mark Center via the two new direct ramps.

Overall, the benefits under this concept would be significant compared to the other conceptual alternatives. However, this concept also require relatively high construction costs and would have both positive and negative impacts associated with these extensive improvements. When comparing Concept 3 versus Concept 2, the benefits obtainable by providing the two new direct access ramps versus just one direct access ramp as assumed in Concept 2 would be fairly similar at all the study intersections except at the two access locations to the new direct ramps. Under Concept 3, less congestion will be anticipated at the direct access points to the Mark Center and the internal circulation roadways would be expected to perform better by providing the separate access for the BRAC 133 project trips and the rest of the Mark Center tenants.

The following is a summary of the key benefits and disadvantages of Conceptual Alternatives 3:

- Benefits
 - By providing two separate direct ramps based on destination within Mark Center, capacity at each direct access ramps will be increased and less congestion will be anticipated at the direct access points to the Mark Center. Also the internal circulation roadways within Mark Center would be expected to perform better by providing the separate access for the BRAC 133 project trips and the rest of the Mark Center tenants.
 - Further improves the operations during AM peak hour conditions at the key intersections serving the project site which are the intersections at Seminary Rd / N. Beauregard St and N. Beauregard St / Mark Center Dr. This would be possible by providing additional access via direct access ramp and diverting not only the BRAC 133 project trips but also trips made by the existing and future Mark Center tenants.
 - Further improves operations at Seminary Rd / Mark Center Dr during PM peak hour conditions by providing additional egress via direct access ramp.
- Disadvantages
 - Entails significant ROW impacts at the two new access ramps, including undergoing Interchange modification procedure.
 - Major construction efforts would be required due to grade separating the access ramp under tight spacing requirements.
 - Current geometry of the I-395 southbound on ramp would have to be reconfigured and the free right turn channelized ramp would need to be removed and dual right turns will be added which would deteriorate the operations at this intersection.
 - Weaving distance between the new ramp and the I-395 southbound on ramp intersection would be fairly short and some turbulence would occur due to the weaving maneuver.
 - Heavy diverted trips accessing/egressing via direct ramp may cause congestion of the operations of the Mark Center internal circulation roadway.
 - Depending on the level of congestion of the internal circulation roadway, there is possibility of vehicle spill back which would affect the traffic flow along the I-395 southbound on ramps and potentially operations along Seminary Rd eastbound approach. Also, depending on the processing time required to clear the vehicles at the security check point at the entrance to the south parking garage, there is possibility of vehicle spill back at the access point which would affect the traffic flow along the I-395 southbound on ramps and potentially operations along Seminary Rd eastbound approach.
 - In case of spillback caused by congestion on internal roads or due to increased processing time at security gate, traffic will divert to the intersections at Seminary Rd / N. Beauregard St and N. Beauregard St / Mark Center Dr.
 - Driver way finding could be confusing to traffic that is re-routed to the new direct access ramps. Rerouting could increase driver confusion due to multiple turn movements over a short distance.
 - Possibility of cut through traffic not destined to Mark Center accessing this direct access ramp therefore increasing congestion along the internal circulation roadways.

5.4. Additional Left Turn Lanes without New Ramp (Concept 4)

Conceptual Alternative 4 provides additional capacity for the left turn lanes at the following critical approaches without any direct ramp connection from and to I-395 southbound off ramp.

- Seminary Rd / N.Beauregard St intersection – addition of a westbound left-turn lane along Seminary Rd to improve this approach from a dual to triple left turn lane configuration.
- N.Beauregard St / Mark Center Dr intersection - addition of a southbound left-turn lane along N.Beauregard St to improve this approach from a single to a dual left turn lane configuration.

Under this concept, all the project trips accessing the project site will be limited to travel along Seminary Rd and N.Beauregard St in order to access and egress the project site. During the AM peak hour conditions, there would be heavy left turn demand for the westbound approach along Seminary Rd at Seminary Rd / N. Beauregard St and Seminary Rd / Mark Center Dr intersections. In order to access the project site, once the project trip completes the left turn maneuver along Seminary Rd westbound approach at Seminary Rd / N. Beauregard St, project trips would be required to make immediate left turn maneuver along N. Beauregard St southbound approach at N. Beauregard St / Mark Center Dr intersection. During PM peak hour conditions, possible exit points from the project site will be limited at Seminary Rd / Mark Center Dr and N. Beauregard St / Mark Center Dr intersections with heavy right turn demand intending to exit from the project site at these intersections.

Traffic volume projections at each intersection for Conceptual Alternative 4 are identical to those assumed for 2013 future year baseline conditions as summarized in **Figure 5**. Similar for 2013 future year baseline conditions, it was assumed that the project trips from I-395 ramps after merging onto Seminary Rd westbound approach would be prohibited from making immediate left turn at Seminary Rd / Mark Center Dr. Using the projected volumes, traffic operational analyses was performed and **Table 18** presents the MOE results at the study intersections under the Conceptual Alternative 4 for the future 2013 AM and PM peak hour conditions.

Table 18: 2013 Concept 4 with Additional Left Turn Lanes but No New Ramp - Intersection MOEs

No.	Intersection Location	Control Type	2013 Concept 4 AM Peak Hour Condition			2013 Concept 4 PM Peak Hour Condition		
			V/C	LOS	Delay (sec/veh)	V/C	LOS	Delay (sec/veh)
1	Seminary Rd / N. Beauregard St	Signal	0.96	E	76.1	0.91	D	47.8
	Eastbound			F	88.1		C	22.5
	Westbound			E	71.2		D	53.6
	Northbound			E	75.6		E	64.2
	Southbound			E	63.2		E	73.5
2	N. Beauregard St / Mark Center Dr	Signal	0.81	C	29.1	0.86	C	30.7
	Eastbound			E	62.7		C	27.1
	Westbound			E	64.7		D	53.0
	Northbound			D	36.0		C	25.0
	Southbound			C	20.4		C	27.2
3	Seminary Rd / Mark Center Dr	Signal	0.84	C	29.3	1.13	F	102.5
	Eastbound			B	17.1		D	48.0
	Westbound			C	29.8		C	29.6
	Northbound			D	36.5		F	233.9
	Southbound			E	77.1		E	55.1
4	Mark Center Dr / Hilton / CNAC Dr	Stop Sign		B	16.3		F	Err
	Eastbound			A	0.1		A	0.1
	Westbound			A	9.8		A	3.7
	Northbound			F	111.8		F	Err
	Southbound			F	362.1		F	192.9
5	Mark Center Dr / IDA Dr	Signal	0.62	B	10.8	0.58	B	15.2
	Eastbound			A	8.6		A	6.0
	Westbound			B	19.5		B	16.7
	Northbound			B	13.9		B	20.3
	Southbound			B	17.2		B	16.8
6	I-395 SB Off-ramp / Seminary Rd	Signal	0.55	B	10.6	0.54	C	31.3
	Southbound (I-395 SB Off-ramp)			B	17.5		D	54.7
	Westbound			A	4.8		A	6.0
7	I-395 SB On-ramp / Seminary Rd	Signal	0.45	C	30.3	0.97	C	29.6
	Southbound			A	2.8		A	2.5
	Eastbound (I-395 SB On-ramp)			D	40.8		D	39.4
8	I-395 NB Off-ramp / Seminary Rd	Signal	0.68	C	29.7	0.77	D	39.8
	Northbound (I-395 NB Off-ramp)			D	53.2		F	95.3
	Eastbound			A	3.6		A	3.7
9	I-395 NB On-ramp / Seminary Rd	Signal	0.53	B	11.4	0.45	B	11.5
	Northbound			A	1.5		A	2.0
	Westbound (I-395 NB On-ramp)			C	28.3		C	34.3
10	Seminary Rd / Library Ln	Signal	1.00	C	27.9	0.78	C	23.1
	Eastbound			C	34.4		B	13.9
	Westbound			C	20.2		B	18.6
	Northbound			E	72.3		D	41.2
	Southbound			E	76.1		F	123.1

Note: Results are from the HCM module in Synchro.

No.	Intersection Location	Control Type	2013 Concept 4 AM Peak Hour Condition			2013 Concept 4 PM Peak Hour Condition		
			V/C	LOS	Delay (sec/veh)	V/C	LOS	Delay (sec/veh)
11	Seminary Rd / George Mason Dr	Signal	0.56	C	34.6	1.05	F	104.3
	Eastbound (Seminary Rd)			C	28.2		F	79.7
	Westbound (Seminary Rd)			D	36.6		E	77.4
	Northbound (Shopping Plaza)			D	43.2		F	175.0
	Southbound (S George Mason Dr)			D	44.1		E	58.3
12	Seminary Rd / Dawes Ave	Signal	0.55	A	6.1	0.75	B	17.0
	Eastbound			A	4.7		B	15.8
	Westbound			A	3.6		B	13.1
	Northbound			E	65.8		D	49.5
	Southbound			E	64.9		E	57.3
13	Seminary Rd / Echols Ave	Signal	0.65	B	10.6	1.03	E	60.2
	Eastbound			B	11.1		B	11.1
	Westbound			A	6.5		F	113.6
	Northbound			E	66.0		E	57.0
	Southbound			E	68.3		E	58.2
14	N. Beauregard St / Fillmore Ave	Signal	0.29	B	11.2	0.35	B	13.1
	Eastbound			E	58.3		D	46.0
	Westbound			E	61.4		D	49.0
	Northbound			A	6.9		B	11.6
	Southbound			A	6.5		A	7.3
15	N. Beauregard St / W Braddock Rd	Signal	0.33	C	34.4	0.5	C	35.0
	Eastbound			E	65.4		D	53.5
	Westbound			E	64.6		E	55.1
	Northbound			B	11.4		C	24.2
	Southbound			C	25.4		C	29.1

Note: Results are from the HCM module in Synchro.

Under Conceptual Alternative 4, operations at Seminary Rd / N. Beauregard St and N. Beauregard St / Mark Center Dr intersections are expected to improve especially during AM peak hour conditions with approximately 37% reduction in delay at the intersections of Seminary Rd / N. Beauregard St and approximately 73% reduction in delay N. Beauregard St / Mark Center compared to the 2013 Baseline conditions. With Concept 4, LOS F (with delay of 121.3 sec/veh), which would occur for the 2013 baseline condition would be improved to LOS E (with delay of 76.1 sec/veh) at the Seminary Rd / N. Beauregard St intersection. At the N. Beauregard St / Mark Center intersection LOS F (with delay of 109.6 sec/veh) for 2013 baseline condition would be improved to LOS C (with delay of 29.1 sec/veh) under Concept 4. Therefore, by providing the additional left turn lanes along westbound Seminary Rd and southbound N. Beauregard St at the intersections of Seminary Rd / N. Beauregard and N. Beauregard St / Mark Center Dr respectively would improve the operations during AM peak periods based on Synchro analysis. Since the physical geometry improvements are limited at these two

intersections, all of the rest of the study intersections would be expected to operate similarly as with 2013 Baseline conditions with LOS D or better.

Since the proposed additional left turn lanes at Seminary Rd / N. Beauregard St and Beauregard St / Mark Center Dr will have no impact to the project trips exiting from the site during PM peak hour conditions, all of the study intersections would be expected to operate similarly as compared to 2013 Baseline conditions with Seminary Rd / Mark Center Dr and Mark Center Dr / Hilton / CNAC Dr intersections expected to operate over capacity (LOS F) mainly due to the project trips egressing the project site via these intersections. The Seminary Rd / George Mason Dr intersection is also expected to continue operating above capacity (LOS F). All of the remaining study intersections would operate at LOS E or better during PM peak hour conditions.

The following is a summary of the key benefits and disadvantages of Conceptual Alternative 4:

- Benefits
 - Improves capacity for critical left turn movements which are westbound left at Seminary Rd / N. Beauregard St intersection and southbound left at N. Beauregard St / Mark Center Dr intersection. Improves traffic operations at these intersections mostly during AM peak hour conditions compared to the 2013 Baseline conditions.
 - Involves relatively less ROW impacts compared to other conceptual alternatives.
 - Construction period and cost is anticipated to be less compared to other conceptual alternatives.
- Disadvantages
 - Operational improvement would be limited to the project trips accessing the site during AM peak hour conditions and would not benefit operations for the project trips exiting the site during PM peak hour conditions.
 - Considering the additional project trips that would make left turns at the Seminary Road westbound approach, the distance needed for the merge maneuver of the project trips coming from the I-395 ramps appears to be insufficient for the crossing of two lanes to enter into the triple left lanes which may result in an adverse impact on the I-395 Seminary Road interchange and Seminary Road westbound approach.
 - Reconfiguration would potentially require longer crosswalks at the Seminary Rd / N. Beauregard St intersection due to the lane widening along Seminary Rd westbound and N. Beauregard St southbound approach. This would generally degrade the mobility for the vehicular operations by providing additional pedestrian crossing time decreased green time for the critical intersection movements.
 - Potential spillback at turn bays due to heavy left turn volumes.

Analysis results for Concept 4 were also compared with the results previously reported for the corresponding concept in the VDOT Mark Center (BRAC) Transportation Study prepared in April 2009. Based on the comparison, it was found that the overall reported LOS were fairly similar at the study intersections especially at the three critical intersection serving the BRAC 133 project site, while slightly better operations would be obtainable at the intersections with I-395 ramps when compared to the results reported in the VDOT study. The discrepancy at the intersections with I-395 ramps would mainly be due to the difference in the assumed input volume, difference in lane configuration modification assumed at the intersections with I-395 Northbound ramps and Seminary Road, and the difference in the signal timing assumption. However regardless of these slight discrepancies, analyses results from both studies confirm the findings that Concept 4 would need new direct access.

5.5. Capacity Analyses Summary

Capacity analyses for the four conceptual alternatives as well as additional variants of those conceptual alternatives were conducted in an effort to evaluate and identify the benefits and disadvantages of each of the conceptual alternative in terms of improving the accessibility to and from the Mark Center site with the addition of the BRAC 133 and future project trips.

The capacity analyses indicate that all of these alternatives would be expected to provide operational benefits at the critical intersections such as Seminary Rd / N. Beauregard St, N. Beauregard St / Mark Center Dr and Seminary Rd / Mark Center Dr which are located immediate vicinity to the project site and serves as the access points to the project. However, depending on the concept, the expected operational benefit and disadvantages would vary and the details are discussed for both AM and PM peak hour conditions below.

AM Peak Period

Table 19 summarizes the MOE comparison summary between 2013 baseline conditions with the four alternatives evaluated which are Conceptual Alternatives 1, 2, 3, and 4 during the AM peak hour conditions. The Conceptual Alternatives 1, 2, and 3 assumes direct ramp connection from I-395 southbound on ramp to the Mark Center to be in place without additional left turn lanes along westbound Seminary Rd and southbound N. Beauregard St at the intersections of Seminary Rd / N.

Beauregard and N. Beauregard St / Mark Center Dr respectively while Concept 4 includes the addition of left turns lanes at these intersections without any direct access ramps.

When focusing at the intersections of Seminary Rd / N. Beauregard St and N. Beauregard St / Mark Center Dr which serves as the primary access points to the project site, the overall reduction in delay would occur the highest for Concept 2 and 3 with approximately 60% reduction in delay at the intersections of Seminary Rd / N. Beauregard St and approximately 84% reduction in delay N. Beauregard St / Mark Center compared to the 2013 Baseline conditions. With Concept 2 and 3, LOS F (with delay of 121.3 sec/veh) which would occur for 2013 baseline condition would be improved to LOS D (with delay of 47.9 and 47.7 sec/veh) at Seminary Rd / N. Beauregard St intersection and LOS F (with delay of 109.6 sec/veh) for 2013 baseline condition would be improved to LOS B (with delay of 17.5 and 16.8 sec/veh) at N. Beauregard St / Mark Center intersection. This significant reduction in delay for these concepts at these two locations is mainly due to the diversion of the project trips accessing the project site via the new direct access ramp.

Conceptual Alternative 1 would be the next most effective concept in terms reducing the overall reduction in delay. Under the concept, there would be approximately 40% reduction in delay at the intersections of Seminary Rd / N. Beauregard St and approximately 62% reduction in delay N. Beauregard St / Mark Center compared to the 2013 Baseline conditions. Also, LOS F (with delay of 121.3 sec/veh) which would occur for 2013 baseline condition would be improved to LOS E (with delay of 73.4 sec/veh) at Seminary Rd / N. Beauregard St intersection and LOS F (with delay of 109.6 sec/veh) for 2013 baseline condition would be improved to LOS D (with delay of 41.7 sec/veh) at N. Beauregard St / Mark Center Dr intersection.

Concept 4 would also be effective concept among the four alternatives in terms reducing the overall reduction in delay which would bring approximately 37% reduction in delay at the intersections of Seminary Rd / N. Beauregard St and approximately 73% reduction in delay N. Beauregard St / Mark Center compared to the 2013 Baseline conditions. With Concept 4, LOS F (with delay of 121.3 sec/veh), which would occur for the 2013 baseline condition would be improved to LOS E (with delay of 76.1 sec/veh) at the Seminary Rd / N. Beauregard St intersection. At the N. Beauregard St / Mark Center intersection LOS F (with delay of 109.6 sec/veh) for 2013 baseline condition would be improved to LOS C (with delay of 29.1 sec/veh) under Concept 4. Therefore, by providing the additional left turn lanes

along westbound Seminary Rd and southbound N. Beauregard St at the intersections of Seminary Rd / N. Beauregard and N. Beauregard St / Mark Center Dr respectively would improve the operations during AM peak periods based on Synchro analysis. Since the physical geometry improvements are limited at these key intersections. All the rest of the study intersection would be expected to operate similarly as with 2013 Baseline conditions with LOS D or better.

It was also found that as the project trips would be diverted more heavily to the direct access ramps, the operations at the four intersections with the I-395 ramps with the Seminary Rd will be impacted with increased delay at all of these intersections especially at the intersection of I-395 SB off-ramp / Seminary Rd. However, even under Concepts 2 and 3, which are the conceptual alternatives assumed to divert the heaviest project trips to the direct access ramps, the four intersections with the I-395 ramps with the Seminary Rd would still be expected operate LOS D or better. Therefore, even though the diversion of the project trips to the new direct access ramps would deteriorate the operations at the four intersections with the I-395 ramps with the Seminary Rd, these intersections would still operate acceptably at LOS D or better and the operational benefit obtainable at the critical intersections serving the site with the project trip diversion would be significant. In case of spillback caused by congestion on internal roads or due to increased processing time at security gate, traffic will divert to the intersections at Seminary Rd / N. Beauregard St and N. Beauregard St / Mark Center Dr.

PM Peak Period

Table 20 summarizes the comparison between 2013 baseline conditions with the four alternatives which are Conceptual Alternatives 1, 2, 3, and 4 during the PM peak hour conditions when the issue is the heavy project trips exiting the project site. When focusing at the intersections of Seminary Rd / Mark Center Dr which serves as the major egress point from the project site, the overall reduction in delay would occur the highest for Concept 2 and 3 with approximately 54% reduction in delay. With Concept 2 and 3, LOS F (with delay of 101.2 sec/veh) which would occur for 2013 baseline condition would be improved to LOS D (with delay of 46.2 sec/veh) at Seminary Rd / Mark Center intersection. This significant reduction in delay is mainly due to the diversion of the project trips egressing the project via the direct ramp access.

Conceptual Alternative 1 would be the next most effective concept in terms reducing the overall reduction in delay. Under Concept 1, there would be approximately 33% reduction in delay at the

intersections of Seminary Rd / Mark Center Dr compared to the 2013 Baseline conditions. Under this concept, LOS F (with delay of 101.2 sec/veh) which would occur for 2013 baseline condition would be improved to LOS E (with delay of 68.0 sec/veh) at this intersection.

Since under Conceptual Alternative 4 the proposed additional left turn lanes at Seminary Rd / N. Beauregard St and Beauregard St / Mark Center Dr will have no impact to the project trips exiting from the site during PM peak hour conditions, all the study intersection would be expected to operate similarly as with 2013 Baseline conditions with Seminary Rd / Mark Center Dr.

Similar with AM peak hour conditions, it was also found that as the project trips exiting the project site would be diverted more heavily to the direct access ramps under Concept 2, and 3, the operations at the four intersections with the I-395 ramps with the Seminary Rd will be impacted with increased delay at all of these intersections especially at the intersection of I-395 SB On-ramp / Seminary Rd due to the change in geometry by providing dual right turn lane instead of free right turn channelized lane to get to I-395 southbound on ramp. However, even under Concept 2 and 3 which are the conceptual alternatives assumed to divert the heaviest project trips to the direct access ramp, the four intersections with the I-395 ramps with the Seminary Rd would still be expected operate LOS D or better. Therefore, the operational benefit obtainable at the critical intersections serving the site with the project trip diversion would be significant also in PM peak hour conditions for conceptual alternatives 1, 2, and 3.

Therefore based on the analysis performed using Synchro, Concept 2 and 3 would be most effective in terms of reducing the overall delay while improving intersection operations at the critical intersections for both AM and PM peak hour conditions and Concept 1 and Concept 4 would be the next most effective concept. However, Concept 4 would be would mainly improve operations during AM peak hour conditions.

Although Concepts 2 and 3 would have most significant benefits in terms of improving the operations at the critical intersections by providing additional access points and thus diverting the project trips, the benefits obtainable under these concepts would require extensive improvements and relatively higher construction costs than the other concepts.

Table 19: 2013 AM Conditions - MOE Comparison among all the Conceptual Alternatives

No.	Intersections	2013 Baseline - Build Volumes with Timing/Lane Marking Improvements under Existing Geometry			2013 Concept 4 - Build Volumes with Additional Left Turn Improvements			Without Additional Left Turn Lanes								
								2013 Concept 1 - Build Volumes with BRAC 133 Direct Access Ramps Only			2013 Concept 2 - Build Volumes with Mark Center Direct Access Ramps Only			2013 Concept 3 - Build Volumes with BRAC 133 & Mark Center Direct Access		
		V/C	LOS	Delay (sec/veh)	V/C	LOS	Delay (sec/veh)	V/C	LOS	Delay (sec/veh)	V/C	LOS	Delay (sec/veh)	V/C	LOS	Delay (sec/veh)
1	Seminary Rd / N. Beauregard St	1.09	F	121.3	0.96	E	76.1	0.95	E	73.4	0.78	D	47.9	0.78	D	47.7
2	N. Beauregard St / Mark Center Dr	1.34	F	109.6	0.81	C	29.1	0.96	D	41.7	0.69	B	17.5	0.67	B	16.8
3	Seminary Rd / Mark Center Dr	0.84	C	28.9	0.84	C	29.3	0.78	C	26.4	0.77	C	25.7	0.76	C	25.5
4	Mark Center Dr/ Hilton / CNAC Dr		B	16.3		B	16.3		B	10.3		A	8.5		A	8.1
5	Marc Center /IDA Dr	0.62	B	10.8	0.62	B	10.8	0.55	A	9.6	0.45	A	9.2	0.44	A	9.2
6	I-395 SB Off-ramp / Seminary Rd	0.55	B	10.6	0.55	B	10.6	0.60	C	21.9	0.68	D	36.2	0.68	D	37.1
7	I-395 SB On-ramp / Seminary Rd	0.45	C	30.3	0.45	C	30.3	0.44	C	25.7	0.60	D	38.0	0.61	D	37.8
8	I-395 NB Off-ramp / Seminary Rd	0.68	C	29.7	0.68	C	29.7	0.68	D	39.6	0.68	D	49.2	0.68	D	49.2
9	I-395 NB On-ramp / Seminary Rd	0.53	B	11.4	0.53	B	11.4	0.56	B	16.6	0.55	C	20.7	0.56	C	22.2
10	Seminary Rd / Library Ln	1.00	C	27.9	1.00	C	27.9	1.00	C	27.9	1.00	C	27.9	1.00	C	27.9
11	Seminary Rd / George Mason Dr	0.55	C	34.6	0.56	C	34.6	0.56	C	34.6	0.55	C	34.6	0.55	C	34.6
12	Seminary Rd / Dawes Ave	0.55	A	6.4	0.55	A	6.1	0.55	A	5.9	0.55	A	5.8	0.55	A	5.9
13	Seminary Rd / Echols Ave	0.65	B	11.2	0.65	B	10.6	0.65	B	11.5	0.65	B	11.8	0.65	B	11.7
14	N. Beauregard St / Fillmore Ave	0.29	B	11.0	0.29	B	11.2	0.29	B	10.8	0.29	B	11.8	0.29	B	11.5
15	N. Beauregard St / W Braddock Rd	0.33	C	34.1	0.33	C	34.4	0.33	C	34.3	0.33	C	35.0	0.33	C	35.0

Note: Results are from the HCM module in Synchro.

Table 20: 2013 PM Conditions - MOE Comparison among all the Conceptual Alternatives

No.	Intersections	2013 Baseline - Build Volumes with Timing/Lane Marking Improvements under Existing Geometry			2013 Concept 4 - Build Volumes with Additional Left Turn Improvements			Without Additional Left Turn Lanes								
								2013 Concept 1 - Build Volumes with BRAC 133 Direct Access Ramps Only			2013 Concept 2 - Build Volumes with Mark Center Direct Access Ramps Only			2013 Concept 3 - Build Volumes with BRAC 133 & Mark Center Direct Access		
		V/C	LOS	Delay	V/C	LOS	Delay	V/C	LOS	Delay	V/C	LOS	Delay	V/C	LOS	Delay
				(sec/veh)			(sec/veh)			(sec/veh)			(sec/veh)			(sec/veh)
1	Seminary Rd / N. Beauregard St	0.93	D	46.9	0.91	D	47.8	0.92	D	45.1	0.87	D	44.9	0.9	D	43.0
2	N. Beauregard St / Mark Center Dr	0.85	C	30.1	0.86	C	30.7	0.85	C	29.7	0.85	C	27.6	0.85	C	27.7
3	Seminary Rd / Mark Center Dr	1.13	F	101.2	1.13	F	102.5	1.00	E	68.0	0.91	D	46.2	0.91	D	46.2
4	Mark Center Dr / Hilton / CNAC Dr		F	Err		F	Err		F	Err		F	Err		F	Err
5	Marc Center /IDA Dr	0.58	B	15.2	0.58	B	15.2	0.50	B	14.1	0.41	B	12.2	0.41	B	12.2
6	I-395 SB Off-ramp / Seminary Rd	0.54	C	31.3	0.54	C	31.3	0.55	C	32.6	0.56	D	39.7	0.57	D	39.5
7	I-395 SB On-ramp / Seminary Rd	0.97	C	29.6	0.97	C	29.6	0.82	C	27.0	0.52	D	54.9	0.52	D	50.6
8	I-395 NB Off-ramp / Seminary Rd	0.77	D	39.8	0.77	D	39.8	0.77	D	40.0	0.77	D	46.5	0.77	D	46.6
9	I-395 NB On-ramp / Seminary Rd	0.45	B	11.5	0.45	B	11.5	0.45	B	11.7	0.46	B	12.8	0.46	B	13.1
10	Seminary Rd / Library Ln	0.78	C	23.1	0.78	C	23.1	0.78	C	23.1	0.78	C	23.1	0.78	C	23.1
11	Seminary Rd / George Mason Dr	1.05	F	104.3	1.05	F	104.3	1.05	F	104.3	1.05	F	104.3	1.05	F	104.3
12	Seminary Rd / Dawes Ave	0.75	B	17.0	0.75	B	17.0	0.75	B	17.0	0.75	B	17.0	0.75	B	17.0
13	Seminary Rd / Echols Ave	1.03	E	61.9	1.03	E	60.2	1.03	E	61.8	1.03	E	62.9	1.03	E	62.4
14	N. Beauregard St / Fillmore Ave	0.35	B	13.2	0.35	B	13.1	0.35	B	13.1	0.35	B	12.8	0.35	B	12.9
15	N. Beauregard St / W Braddock Rd	0.5	C	34.8	0.5	C	35.0	0.5	C	34.8	0.5	C	34.8	0.5	C	34.8

Note: Results are from the HCM module in Synchro.

5.6. Additional Improvement Measures

As summarized in **Table 19** and **Table 20**, all the conceptual alternatives would be anticipated to improve the operations at the critical intersections located in the immediate vicinity of the project site which would serve as the key access points. However, during PM peak hour conditions there are few intersections which would continue to operate at or over capacity during the 2013 baseline conditions where the evaluated concepts would have no effect in terms of improving the operations. Based on the findings from the analyses, the intersection that would continue to operate over capacity for all the alternatives are the intersection of Seminary Rd / George Mason Dr, while intersection of Seminary Rd / Echols Ave would continue to operate at capacity. Potential improvement measures were evaluated at these intersections in order to improve the operations. Intersections of Seminary Rd / Dawes Ave, N. Beauregard St / Fillmore Ave, and N. Beauregard St / W Braddock Rd would operate under capacity for all the conceptual alternatives for both AM and PM peak hour conditions.

At the intersection of Seminary Rd / George Mason Dr, the intersection would operate over capacity mainly due to the heavy Seminary Rd southbound right turn movement. Therefore, there would be operational benefits to this intersection by providing additional capacity for this critical right turn movement. One feasible option would be to restripe the current lane marking for Seminary Rd southbound approach from a left turn lane, a shared left plus through lane, and a right turn lane into a shared left and through lane, and dual right turn. Although this improvement measure would entail demolishing the right turn channelized island, the operational benefit would be noticeable from this reconfiguration in lane usage. The volumes show that there would be significantly lower left turn and through volume when compared to the higher right turn volume for the southbound approach along Seminary Rd. Based on Synchro analysis with the assumed improvement measures, the delay would be reduced to LOS E (with delay of 64.3) when compared to the 2013 baseline conditions of LOS F (with delay of 104.3). The delay would be further reduced to LOS D (with delay of 42.2) when this right turn phase would be allowed to overlap with the Seminary Rd westbound left turn approach.

At the intersection of Seminary Rd / Echols Ave, the intersection would operate at capacity mainly due to the fact that the left turn and the through movement along the Seminary Rd westbound approach would be sharing the inner lane. For this approach, by providing separate storage lane for the Seminary Rd westbound approach left turn vehicles would not constrain the westbound through movement in case the left turn vehicles cannot find the sufficient gap to make the left turn maneuver. Based on

Synchro analysis with the improvement measures, the delay would be reduced to LOS B (with delay of 12.5) when compared to the 2013 baseline conditions of LOS E (with delay of 61.9). The potential improvement measures discussed above will involve some degree of ROW acquisition and utilities relocation. Also improvement at the intersection of Seminary Rd / George Mason Dr would require close coordination with VDOT since the intersection is outside the jurisdiction of the City of Alexandria.

6. Traffic Simulation Analysis

Micro-simulation traffic analysis was performed using the VISSIM software package (Version 5.10). This micro-simulation analysis was conducted as a supplement to the HCM output results obtained from Synchro analysis and is intended to examine more in detail, both how the operations and traffic flow of one of individual intersections affect adjacent intersections and how traffic moves through the system as a whole. Synchro is a discrete, location-based analysis tool that is based on deterministic traffic relationships but it does not actually model interactions among vehicles or “track” individual vehicle movements. Synchro also does not account for the effects of traffic flow at adjacent intersections. On the other hand, VISSIM is a microscopic simulation model, which simulates the movement of individual vehicles, lane changing, and more accurately represents highly congested conditions, accounts for queue spillbacks affecting upstream intersections and appropriately quantifies resulting reduction of throughput for atypical traffic situations. VISSIM accurately accounts for other factors including closely spaced intersections, complex phasing and non-traditional signal systems operation, and as a whole, the VISSIM program carries these functions across the entire system being modeled to determine the system-wide impacts. Therefore, for the study area intersections that are closely spaced, factors such as progression, queue spillback, and bottlenecks at one intersection would directly affect the operations at the adjacent intersections. To address these factors, the HCM analysis was supplemented with VISSIM. A VISSIM model network was prepared for the study area and included all the study intersections included in Synchro analysis. In particular, focus was given to the critical intersections serving the project sites which are Seminary Rd / N. Beauregard St, N. Beauregard St / Mark Center Dr, Seminary Rd / Mark Center Dr, and four intersections with I-395 ramps. Concepts 1 and 2 were selected for further evaluation based on the results of the Synchro capacity analyses. A complete summary table, which includes results for all the study intersections, is included in **Appendix D**.

The options selected for detailed micro-simulation evaluation include 2013 Conceptual Alternatives

Baseline, Concept 1, 2, and 4 for AM peak hour conditions. Concept 3 was excluded in this analysis since this concept is expected to yield similar performance to that of Concept 2, except in the vicinity of where the direct ramps will be connected. For PM peak hour conditions, detailed analyses for 2013 Baseline and Concept 2 were selected. Concept 2 which would be expected to yield the highest diversion of the project trips among the alternatives analyzed for PM peak hour conditions. This was done in order to evaluate the operational impacts that the egress trips from the direct access ramps to the I-395 southbound on ramps maneuver along with the impact to the traffic operations at the intersections vicinity to the project site. Also, the impact of constructing the direct access ramp which would require the intersection of I-395 SB On-Ramp / Seminary Rd to be reconfigured from the existing right turn channelized lanes has been simulated.

As an initial step, a VISSIM traffic flow simulation model that includes all of the fifteen study intersections was developed for the existing condition for AM and PM peak hour conditions were prepared. This model was used then to produce detailed traffic operations impacts of the scenarios being tested. In addition, as included in Chapter 7 of the report, potential interim solutions between 2011 when the BRAC 133 buildings will be occupied and 2013 when the construction of the new ramp will be completed were also evaluated using VISSIM since there were limitations in assessing the effect of detail geometry changes with Synchro analysis.

6.1. Existing Conditions

As a first step, data compilation and network coding was performed to prepare the input data and the model network. In addition, model verification was conducted with the available data to replicate the existing weekday AM and PM peak conditions in the field. For this purpose, VISSIM model was refined where necessary to reflect the representative queues and the throughput from the VISSIM to match the traffic counts as close as possible. **Table 21** and **Table 22** presents the Measures of Effectiveness (MOEs) for the critical intersections surrounding the site for the existing weekday AM and PM peak hour conditions within the study area from the VISSIM analysis. Based on the VISSIM simulation results, the summary tables indicate that all of the study intersections are operating at LOS E or better for all the study intersections during AM and PM peak hour conditions with for I-395 NB Off-ramp / Seminary Rd intersection currently operating at capacity with LOS E during both the AM and PM peak hour conditions due to heavy I-395 northbound off-ramp volumes, which is not fully serviced during the allocated signal green time.

Table 21: Existing AM Peak Hour Conditions Key Signalized Intersection - VISSIM MOEs

AM Operations			Existing Conditions							
			Demand	Throughput	Throughput VS Demand	Delay (s)	Ave Queue (ft)	Max Queue (ft)	Ave Intersection Delay (s)	LOS
Seminary Rd & N. Beauregard St	Seminary Rd EB	LT	60	64	-4	52.2	17.6	99.8	39.7	D
		Thru	980	1,001	-21	36.4	91.5	437.4		
		RT	160	180	-20	2.9	0.4	85.6		
	Seminary Rd WB	LT	540	544	-4	88.0	181.7	613.1		
		Thru	1,100	1,086	14	22.7	76.8	495.6		
		RT	180	182	-2	9.3	19.0	316.4		
	N. Beauregard St NB	LT	450	466	-16	78.0	150.7	568.3		
		Thru	460	468	-8	34.3	65.0	404.3		
		RT	290	301	-11	2.8	12.1	201.2		
	N. Beauregard St SB	LT	90	105	-15	67.5	39.1	149.7		
Thru		155	125	30	49.6	26.6	131.0			
RT		40	79	-39	22.8	0.0	0.0			
N. Beauregard St & Mark Center Dr	N. Beauregard St NB	LT	50	57	-7	7.1	1.1	51.6	15.4	B
		Thru	1,175	1,198	-23	13.3	28.2	272.6		
		RT	180	176	4	9.8	0.0	0.0		
	N. Beauregard St SB	LT	355	355	0	40.0	65.4	337.8		
		Thru	420	414	6	0.1	1.7	83.5		
		RT	80	82	-2	2.7	5.3	194.7		
	Mark Center Dr EB	LT	10	11	-1	63.9	5.7	55.5		
		Thru	5	5	0	62.9	5.7	55.5		
		RT	5	4	1	57.1	5.7	55.5		
	Mark Center Dr WB	LT	15	21	-6	50.1	14.3	106.3		
Thru		5	13	-8	43.8	14.3	106.3			
RT		15	22	-7	44.2	14.3	106.3			
Seminary Rd & Mark Center Dr	Seminary Rd EB	LT	20	15	5	55.6	4.3	49.5	21.8	C
		Thru	1,275	1,322	-47	12.3	36.9	244.2		
		RT	65	54	11	4.6	1.2	102.1		
	Seminary Rd WB	LT	180	178	2	61.1	69.8	642.1		
		Thru	1,760	1,756	4	17.7	70.4	704.0		
		RT	90	93	-3	16.0	8.1	408.8		
	Marc Center Dr NB	LT	10	12	-2	48.6	7.4	75.6		
		Thru	10	14	-4	56.3	7.4	75.6		
		RT	130	135	-5	5.2	0.0	0.0		
	Marc Center Dr SB	LT	230	223	7	75.9	118.8	415.5		
Thru		50	51	-1	91.0	118.8	415.5			
RT		50	52	-2	11.8	118.8	415.5			
I-395 SB On- Ramp & Seminary Rd	I-395 SB On- Ramp	LT	270	278	-8	6.4	8.6	110.9	39.6	D
		Thru	220	225	-5	5.0	9.0	113.2		
	Seminary Rd WB	Thru	835	845	-10	75.8	201.9	857.7		
		RT	470	486	-16	11.6	27.2	555.5		
I-395 NB Off- Ramp & Seminary Rd	I-395 NB Off- Ramp	Thru	680	661	19	141.5	738.2	1632.1	60.7	E
		RT	195	203	-8	110.2	254.8	1202.0		
	Seminary Rd WB	LT	750	746	4	4.7	7.7	103.9		
		Thru	355	374	-19	2.5	7.7	103.9		
I-395 NB On- Ramp & Seminary Rd	I-395 NB On- Ramp	LT	610	587	23	6.1	12.8	236.7	21.9	C
		Thru	820	820	0	3.1	11.5	227.6		
	Seminary Rd EB	Thru	310	278	32	78.5	193.8	677.3		
		RT	680	697	-17	34.6	66.1	463.9		
I-395 SB Off- Ramp & Seminary Rd	I-395 SB Off- Ramp	Thru	230	241	-11	69.0	56.2	217.8	14.7	B
		RT	480	481	-1	3.0	0.0	9.2		
	Seminary Rd EB	LT	265	261	4	5.0	15.1	169.0		
		Thru	545	609	-64	6.7	15.1	169.0		

Table 22: Existing PM Peak Hour Conditions Key Signalized Intersection - VISSIM MOEs

PM Operations			Existing Conditions							LOS
			Demand	Throughput	Throughput VS Demand	Delay (s)	Ave Queue (ft)	Max Queue (ft)	Ave Intersection Delay (s)	
Seminary Rd & N. Beauregard St	Seminary Rd EB	LT	105	113	-8	86.7	120.4	1214.9	47.5	D
		Thru	1,180	1,226	-46	60.9	453.0	1221.3		
		RT	520	558	-38	30.0	233.1	869.6		
	Seminary Rd WB	LT	425	420	5	70.4	92.7	275.3		
		Thru	1,020	1,026	-6	15.6	44.9	302.7		
		RT	195	197	-2	5.4	0.3	80.9		
	N. Beauregard St NB	LT	360	371	-11	99.4	138.5	439.9		
		Thru	390	388	2	54.8	66.7	330.9		
		RT	335	344	-9	30.8	2.7	68.8		
	N. Beauregard St SB	LT	145	147	-2	62.2	45.6	198.1		
		Thru	425	430	-5	52.6	76.1	258.0		
		RT	45	48	-3	45.1	0.0	0.0		
N. Beauregard St & Mark Center Dr	N. Beauregard St NB	LT	5	7	-2	21.8	0.2	23.0	9.4	A
		Thru	925	951	-26	7.7	13.6	152.6		
		RT	20	25	-5	6.2	0.0	0.0		
	N. Beauregard St SB	LT	20	24	-4	6.7	0.3	28.4		
		Thru	1,335	1,367	-32	0.3	9.3	137.8		
		RT	15	17	-2	2.4	0.8	117.0		
	Mark Center Dr EB	LT	70	68	2	55.7	34.2	175.9		
		Thru	20	19	1	51.4	34.2	175.9		
		RT	30	31	-1	55.6	34.2	175.9		
	Mark Center Dr WB	LT	115	113	2	50.2	65.0	355.4		
		Thru	5	5	0	39.1	65.0	355.4		
		RT	90	89	1	56.5	65.0	355.4		
Seminary Rd & Mark Center Dr	Seminary Rd EB	LT	35	40	-5	66.4	13.8	92.2	27.9	C
		Thru	1,600	1,636	-36	22.1	178.5	817.8		
		RT	25	30	-5	9.8	36.1	373.2		
	Seminary Rd WB	LT	130	133	-3	64.7	66.5	629.3		
		Thru	1,490	1,488	2	25.3	165.2	863.5		
		RT	100	95	5	24.6	38.6	569.4		
	Marc Center Dr NB	LT	80	86	-6	59.4	74.7	277.3		
		Thru	50	51	-1	59.7	74.7	277.3		
		RT	500	527	-27	28.2	10.3	171.1		
	Marc Center Dr SB	LT	185	183	2	54.3	52.0	236.3		
		Thru	10	11	-1	38.9	52.0	236.3		
		RT	70	71	-1	5.4	52.0	236.3		
I-395 SB On- Ramp & Seminary Rd	I-395 SB On- Ramp	LT	680	653	27	6.7	20.6	255.1	30.3	C
		Thru	225	224	1	6.0	20.6	257.7		
	Seminary Rd WB	Thru	760	801	-41	76.9	177.4	947.1		
		RT	1070	1091	-21	15.1	40.0	581.6		
I-395 NB Off- Ramp & Seminary Rd	I-395 NB Off- Ramp	Thru	725	637	88	159.6	1121.4	1673.8	67.4	E
		RT	370	339	31	157.7	1076.8	1673.5		
	Seminary Rd WB	LT	475	475	0	4.1	13.5	156.0		
		Thru	965	980	-15	7.0	13.5	156.0		
I-395 NB On- Ramp & Seminary Rd	I-395 NB On- Ramp	LT	560	507	53	5.2	12.9	256.5	16.6	B
		Thru	640	608	32	2.3	11.8	246.9		
	Seminary Rd EB	Thru	305	310	-5	72.4	79.8	381.2		
		RT	280	286	-6	7.0	2.6	167.9		
I-395 SB Off- Ramp & Seminary Rd	I-395 SB Off- Ramp	Thru	620	624	-4	90.3	183.8	545.1	32.9	C
		RT	410	412	-2	4.9	0.5	73.8		
	Seminary Rd EB	LT	285	258	27	4.7	12.4	140.5		
		Thru	670	647	23	6.5	12.4	140.5		

As shown in **Table 21** during AM peak hour conditions, heavy queues along I-395 off ramp are reflected that occurs along the through and right turn lanes. For PM peak hour conditions, as shown in **Table 22** queues that form along the eastbound Seminary Rd approach at the intersection with N. Beauregard St are reflected. For both time periods, the throughput from the VISSIM model was within the similar range as that of the traffic count. The VISSIM results for these intersections are generally consistent with the results obtained from the HCM analysis, although the magnitude of delay differs somewhat between the two analysis tools, as a result of differing analytical methodologies.

6.2. 2013 Baseline Conditions

The same VISSIM analysis refined network parameters employed for the 2008 Existing Conditions analysis and the previously described future traffic volume projections were used to evaluate 2013 baseline conditions. As described, 2013 baseline conditions would be the case with the project volumes and no improvements in roadway geometry. **Table 23** and **Table 24** presents the MOE results from VISSIM for the critical intersections for the 2013 baseline weekday AM and PM peak hour conditions within the study area.

As shown in **Table 23**, the VISSIM simulation suggests that the intersections of Seminary Rd / N. Beauregard St, N. Beauregard St / Mark Center Dr, Seminary Rd / Mark Center Dr, and I-395 southbound and northbound off-ramp intersections with Seminary Rd are anticipated to operate above capacity during the AM peak hour conditions, mainly due to heavy traffic volume along westbound Seminary Rd with the addition of the project trips.

Along Seminary Road westbound approach at the intersections of Seminary Rd / N. Beauregard St, due to the significant addition of the project trips, heavy left turn demand would exceed the capacity and left turning vehicles would be spilling back and blocking the through lanes, possibly placing a constraint for the Seminary Road westbound approach upstream past Mark Center Drive and trips from I-395 ramps intending to merge onto Seminary Road westbound approach. Therefore, a significant number of left turn and through volumes along Seminary Road westbound approach trips would not be serviced. Along the Seminary Road eastbound approach, through traffic would block the right turn maneuver, causing long queues along eastbound Seminary Road.

Table 23: 2013 Baseline AM Conditions Key Signalized Intersection - VISSIM MOEs

AM Operations			2013 Baseline without Improvement							Ave Intersection Delay (s)	LOS
			Demand	Throughput	Throughput VS Demand	Delay (s)	Ave Queue (ft)	Max Queue (ft)			
Seminary Rd & N. Beauregard St	Seminary Rd EB	LT	60	48	-12	139.9	35.2	484.4	101.8	F	
		Thru	1,275	1,043	-232	132.6	1016.3	1227.7			
		RT	180	136	-44	118.0	669.6	875.9			
	Seminary Rd WB	LT	1,295	764	-531	119.4	536.9	764.5			
		Thru	1,155	729	-426	24.4	76.1	474.5			
		RT	190	110	-80	10.1	218.1	415.2			
	N. Beauregard St NB	LT	465	354	-111	248.8	552.6	783.8			
		Thru	475	392	-83	61.1	462.2	787.9			
		RT	305	243	-62	12.5	188.3	410.0			
	N. Beauregard St SB	LT	145	146	1	161.8	146.3	350.4			
		Thru	195	211	16	85.0	40.5	175.7			
		RT	40	41	1	32.1	10.2	62.3			
N. Beauregard St & Mark Center Dr	N. Beauregard St NB	LT	50	47	-3	118.4	0.9	48.9	118.4	F	
		Thru	1,205	981	-224	216.1	1594.2	1673.9			
		RT	440	338	-102	142.5	1470.2	1569.0			
	N. Beauregard St SB	LT	1,155	769	-386	39.0	364.3	837.1			
		Thru	430	278	-152	6.1	1.6	79.1			
		RT	80	54	-26	6.5	174.5	581.6			
	Mark Center Dr EB	LT	10	9	-1	114.5	5.5	41.8			
		Thru	5	6	1	78.7	5.5	41.8			
		RT	5	4	-1	39.9	5.5	41.8			
	Mark Center Dr WB	LT	35	45	10	68.6	20.1	138.6			
		Thru	5	10	5	57.8	20.1	138.6			
		RT	20	26	6	37.6	20.1	138.6			
Seminary Rd & Mark Center Dr	Seminary Rd EB	LT	20	17	-3	100.3	6.5	48.4	95.6	F	
		Thru	1,350	1,110	-240	15.6	43.1	247.7			
		RT	360	302	-58	3.0	2.6	181.9			
	Seminary Rd WB	LT	530	387	-143	163.3	1515.0	1673.7			
		Thru	2,555	1,533	-1,022	122.7	1516.5	1673.4			
		RT	90	56	-34	96.4	1148.8	1658.6			
	Marc Center Dr NB	LT	35	30	-5	104.5	16.1	118.9			
		Thru	15	9	-6	86.4	16.1	118.9			
		RT	220	185	-35	4.5	0.2	18.5			
	Marc Center Dr SB	LT	235	203	-32	307.3	432.3	604.7			
		Thru	85	62	-23	333.5	432.3	604.7			
		RT	50	45	-5	264.5	432.3	604.7			
I-395 SB On-Ramp & Seminary Rd	I-395 SB On-Ramp	LT	310	65	-245	4.2	1.5	82.8	40.8	D	
		Thru	225	168	-57	2.9	1.6	85.3			
	Seminary Rd WB	Thru	885	722	-163	71.6	149.3	632.5			
		RT	515	434	-81	9.7	13.5	311.2			
I-395 NB Off-Ramp & Seminary Rd	I-395 NB Off-Ramp	Thru	1090	1011	-79	150.2	925.0	1667.9	96.1	F	
		RT	230	225	-5	108.6	945.7	1667.6			
	Seminary Rd WB	LT	795	645	-150	25.8	32.6	273.2			
		Thru	395	141	-254	9.9	32.6	273.2			
I-395 NB On-Ramp & Seminary Rd	I-395 NB On-Ramp	LT	1020	943	-77	28.2	132.1	359.1	48.7	D	
		Thru	870	708	-162	14.5	132.1	359.1			
	Seminary Rd EB	Thru	390	212	-178	277.8	430.0	687.2			
		RT	715	568	-147	40.1	233.2	473.8			
I-395 SB Off-Ramp & Seminary Rd	I-395 SB Off-Ramp	Thru	265	28	-237	614.8	5.2	52.3	181.6	F	
		RT	835	92	-743	1550.7	719.8	746.8			
	Seminary Rd EB	LT	270	204	-66	9.9	131.9	323.9			
		Thru	1025	942	-83	72.4	131.9	323.9			

At the intersection of N. Beauregard St / Mark Center Dr, along the N. Beauregard Street southbound approach, left turn lane demand would also exceed capacity due to the added project trips and left turn vehicles would be expect to spill back and block the through lanes. Along the Seminary Road westbound approach at the intersection of Seminary Rd / Mark Center Dr, left turn lane demand would possibly exceed capacity, and left turn vehicles may block through lanes and spill back impacting the operations of the through lanes.

I-395 southbound and northbound off-ramp intersections with Seminary Rd are anticipated to operate above capacity with the most noticeable delay expected to occur along I-395 southbound off-ramp maneuvers due to the congestion formed at the intersections located downstream. This would also result in significant number of I-395 southbound off-ramp vehicles not being serviced. The proximity of the intersection of Seminary Road/N. Beauregard Street and short distance with where the vehicles from I-395 northbound and southbound ramps merge onto Seminary Road would result in weaving issues and turbulence and blockage for the trips intending to merge onto Seminary Road westbound approach. This may result in an adverse impact on the I-395 Seminary Road interchange and Seminary Road westbound approach.

As summarized in **Table 24**, during the weekday PM peak hour conditions, all of the critical study intersections are expected to operate below or at capacity, except the I-395 southbound off-ramp intersections with Seminary Rd mainly due to the delay that would occur for the through and right turn movements, although the level of delay would be much less than what would occur during that of AM peak hour conditions. Outside the critical intersections, Seminary Rd / George Mason Dr would operate above capacity due to heavy volumes in the eastbound and southbound approaches. Along the Mark Center Dr northbound approach at the intersection of Seminary Rd / Mark Center Dr, mainly due to the heavy trips intending to egress from the project site, right turn lane demand would exceed the capacity and spill back may occur blocking the through lanes and impacting the operations of the internal circulation roadway.

Table 24: 2013 Baseline PM Conditions Key Signalized Intersection VISSIM - MOEs

PM Operations			2013 Baseline without Improvement							LOS
			Demand	Throughput	Throughput VS Demand	Delay (s)	Ave Queue (ft)	Max Queue (ft)	Ave Intersection Delay (s)	
Seminary Rd & N. Beauregard St	Seminary Rd EB	LT	110	107	-3	89.1	129.2	1220.6	69.8	E
		Thru	1,255	1,203	-52	79.8	584.3	1216.1		
		RT	535	502	-33	38.3	336.5	864.3		
	Seminary Rd WB	LT	545	457	-88	75.0	96.1	384.2		
		Thru	1,315	1,158	-157	28.0	89.8	533.0		
		RT	250	220	-30	11.3	5.1	183.9		
	N. Beauregard St NB	LT	385	362	-23	143.7	346.2	742.2		
		Thru	435	408	-27	59.6	339.4	754.3		
		RT	345	282	-63	197.1	174.0	404.7		
	N. Beauregard St SB	LT	155	156	1	122.6	105.7	314.0		
		Thru	440	438	-2	57.2	81.7	293.9		
		RT	45	53	8	59.0	0.0	5.5		
N. Beauregard St & Mark Center Dr	N. Beauregard St NB	LT	5	7	2	18.0	0.3	21.5	34.6	C
		Thru	950	921	-29	55.6	157.7	599.8		
		RT	55	48	-7	43.2	49.3	302.9		
	N. Beauregard St SB	LT	125	119	-6	25.3	10.4	122.7		
		Thru	1,370	1,268	-102	13.1	82.1	720.2		
		RT	15	17	2	11.2	23.2	468.6		
	Mark Center Dr EB	LT	70	74	4	61.8	18.9	116.6		
		Thru	20	19	-1	29.9	18.9	116.6		
		RT	30	24	-6	39.4	18.9	116.6		
	Mark Center Dr WB	LT	370	284	-86	48.7	95.7	477.7		
		Thru	5	3	-2	32.4	95.7	477.7		
		RT	140	105	-35	63.2	95.7	477.7		
Seminary Rd & Mark Center Dr	Seminary Rd EB	LT	35	31	-4	81.3	12.1	82.8	51.8	D
		Thru	1,655	1,510	-145	38.2	382.6	991.6		
		RT	65	66	1	22.8	113.0	593.0		
	Seminary Rd WB	LT	180	195	15	70.1	1145.0	1483.7		
		Thru	1,670	1,594	-76	58.3	1264.0	1482.1		
		RT	105	103	-2	49.8	609.7	1186.8		
	Marc Center Dr NB	LT	365	194	-171	96.3	318.6	385.9		
		Thru	85	46	-39	94.5	318.6	385.9		
		RT	1,560	889	-671	50.0	318.6	385.9		
	Marc Center Dr SB	LT	190	182	-8	62.2	62.6	234.2		
		Thru	15	17	2	57.5	62.6	234.2		
		RT	70	69	-1	5.9	62.6	234.2		
I-395 SB On- Ramp & Seminary Rd	I-395 SB On- Ramp	LT	710	627	-83	4.2	3.1	192.5	28.0	C
		Thru	230	228	-2	0.9	1.9	195.0		
	Seminary Rd WB	Thru	1110	837	-273	68.4	167.4	1018.6		
		RT	1480	1127	-353	16.8	45.0	663.8		
I-395 NB Off- Ramp & Seminary Rd	I-395 NB Off- Ramp	Thru	795	808	13	50.5	216.0	684.3	25.5	C
		RT	390	424	34	46.5	249.7	726.2		
	Seminary Rd WB	LT	820	626	-194	1.7	25.6	182.7		
		Thru	1000	841	-159	8.6	25.6	182.7		
I-395 NB On- Ramp & Seminary Rd	I-395 NB On- Ramp	LT	625	634	9	2.0	0.6	86.5	14.9	B
		Thru	990	802	-188	1.0	0.6	86.5		
	Seminary Rd EB	Thru	315	314	-1	85.3	117.4	310.6		
		RT	360	356	-4	7.2	3.0	97.2		
I-395 SB Off- Ramp & Seminary Rd	I-395 SB Off- Ramp	Thru	650	569	-81	144.5	775.9	1245.3	96.2	F
		RT	465	394	-71	217.4	491.7	755.2		
	Seminary Rd EB	LT	290	288	-2	3.6	9.2	134.9		
		Thru	740	734	-6	30.1	9.2	134.9		

6.3. 2013 Conditions with New Ramp to the South Parking Garage (Concept 1)

The same parameters assumed in the 2013 Baseline Conditions analysis were used to analyze Conceptual Alternative 1 using VISSIM micro-simulation analysis. Conceptual Alternative 1 provides a direct ramp connection from I-395 southbound on ramp to the proposed South parking garage located at the BRAC 133 site.

Only AM peak hour conditions have been analyzed in VISSIM for Concept 1 since 2013 baseline micro-simulation results showed that majority of the critical intersections located vicinity to the site would operate over capacity during AM peak hour conditions while during PM peak hour conditions would operate at or below capacity even with the addition of the project trips. **Table 25** presents the MOEs results from VISSIM for the critical intersections for Conceptual Alternative 1 during weekday AM peak hour conditions within the study area assuming that the new direct ramp connection to the South parking garage but without additional left turn lanes along Seminary Rd westbound approach at Seminary Rd/Beauregard St intersection and along N. Beauregard St southbound approach at Beauregard St/Mark Center Dr intersection. It was also assumed based on the input provided that there would be no constraints at the security check point access to the new South parking garage and measures would be taken at the facility to prevent vehicles from spilling back to I-395 ramps.

The intersections of Seminary Rd / N. Beauregard St, N. Beauregard St / Mark Center Dr, and I-395 southbound off-ramp intersection with Seminary Rd are anticipated to operate above capacity during the AM peak hour conditions, mainly due to heavy traffic volume along westbound Seminary Rd with the addition of the project trips, but the delay would be reduced when compared to 2013 baseline conditions. Although the LOS would still be F, there would be further reduction in delay from 101.8 sec/veh sec which would occur for 2013 baseline condition that would be improved to 87.1 sec/veh at Seminary Rd / N. Beauregard St intersection and LOS F (with delay of 118.4 sec/veh) for 2013 baseline condition would be improved to LOS F (with delay of 101.4 sec/veh) at N. Beauregard St / Mark Center Dr intersection. Significant reduction in delay is anticipated at the Seminary Rd / Mark Center Dr intersection where LOS F (with delay of 95.6 sec/veh) for the 2013 baseline condition would be improved to LOS E (with delay of 61.9 sec/veh).

Table 25: 2013 AM Conditions with Concept 1 Key Signalized Intersection - VISSIM MOEs

AM Operations			2013 Concept 1 without Stop Sign at the new ramp & without Additional Left Turn							LOS
			Demand	Throughput	Throughput VS Demand	Delay (s)	Ave Queue (ft)	Max Queue (ft)	Ave Intersection Delay (s)	
Seminary Rd & N. Beauregard St	Seminary Rd EB	LT	60	51	-9	117.3	17.9	121.6	87.1	F
		Thru	1,275	1,137	-138	116.9	941.3	1228.0		
		RT	180	162	-18	70.7	602.3	876.2		
	Seminary Rd WB	LT	850	688	-162	111.8	422.4	760.1		
		Thru	1,155	998	-157	26.3	92.5	656.2		
		RT	190	163	-27	11.3	127.8	409.6		
	N. Beauregard St NB	LT	465	408	-57	184.2	537.2	792.5		
		Thru	475	460	-15	94.3	457.3	796.8		
		RT	305	288	-17	36.0	178.6	418.7		
	N. Beauregard St SB	LT	145	152	7	98.5	81.5	289.3		
		Thru	195	206	11	66.1	37.0	175.8		
		RT	40	41	1	31.6	0.3	17.6		
N. Beauregard St & Mark Center Dr	N. Beauregard St NB	LT	50	52	2	76.5	0.9	51.8	101.4	F
		Thru	1,205	1,149	-56	169.2	1005.3	1625.0		
		RT	440	412	-28	109.5	768.4	1463.0		
	N. Beauregard St SB	LT	710	622	-88	46.6	238.0	807.0		
		Thru	430	373	-57	3.5	1.3	85.9		
		RT	80	60	-20	4.1	77.7	552.9		
	Mark Center Dr EB	LT	10	9	-1	120.5	5.9	47.3		
		Thru	5	7	2	88.9	5.9	47.3		
		RT	5	4	-1	49.3	5.9	47.3		
	Mark Center Dr WB	LT	35	47	12	67.1	18.7	95.0		
		Thru	5	5	0	88.6	18.7	95.0		
		RT	20	31	11	41.6	18.7	95.0		
Seminary Rd & Mark Center Dr	Seminary Rd EB	LT	20	18	-2	74.5	6.0	48.9	61.9	E
		Thru	1,350	1,214	-136	26.4	106.0	632.8		
		RT	360	321	-39	5.3	18.6	403.5		
	Seminary Rd WB	LT	465	417	-48	99.2	1338.6	1483.7		
		Thru	2,110	1,765	-345	74.5	1332.2	1482.1		
		RT	90	78	-12	55.6	641.0	1186.9		
	Marc Center Dr NB	LT	35	37	2	78.8	21.1	100.6		
		Thru	15	18	3	72.1	21.1	100.6		
		RT	200	186	-14	7.5	0.1	8.1		
	Marc Center Dr SB	LT	235	226	-9	158.4	273.9	518.2		
		Thru	85	75	-10	196.6	273.9	518.2		
		RT	50	51	1	80.5	273.9	518.2		
I-395 SB On- Ramp & Seminary Rd	I-395 SB On- Ramp	LT	310	203	-107	1.6	8.6	117.3	44.6	D
		Thru	735	639	-96	6.2	10.2	119.9		
	Seminary Rd WB	Thru	885	831	-54	94.3	277.1	956.2		
		RT	495	452	-43	26.8	48.3	590.7		
I-395 NB Off- Ramp & Seminary Rd	I-395 NB Off- Ramp	Thru	1090	1118	28	70.3	360.3	819.2	38.6	D
		RT	230	227	-3	32.9	384.3	847.4		
	Seminary Rd WB	LT	795	746	-49	4.7	13.1	150.3		
		Thru	395	284	-111	7.5	13.1	150.3		
I-395 NB On- Ramp & Seminary Rd	I-395 NB On- Ramp	LT	1020	1051	31	9.0	20.2	358.1	33.9	C
		Thru	870	816	-54	3.2	20.2	358.1		
	Seminary Rd EB	Thru	455	403	-52	154.0	413.2	677.8		
		RT	715	612	-103	38.7	213.8	464.4		
I-395 SB Off- Ramp & Seminary Rd	I-395 SB Off- Ramp	Thru	500	320	-180	186.1	292.2	939.5	110.7	F
		RT	600	319	-281	382.3	693.7	750.4		
	Seminary Rd EB	LT	545	526	-19	4.8	40.0	301.7		
		Thru	815	828	13	44.2	40.0	301.7		

Although, the micro-simulation results indicate some improvement the results for Concept 1 do not show as much improvement from the results from that of the capacity analysis where the intersection would be anticipated to operate at capacity. As discussed this is due to the fact that micro-simulation model which simulates the movement of individual vehicles, and lane changing maneuvers, accounts for queue spillbacks affecting upstream intersections and appropriately quantifies resulting reduction of throughput for atypical traffic situations.

The operations at some of the intersections with the I-395 ramps would generally improve when compared to the 2013 baseline conditions due to the diversion that will occur for the project trips accessing the site via the new direct ramp with most noticeable reduction in delay expected at I-395 southbound and northbound off-ramp intersections with Seminary Road. Although some of the critical intersections would still operate over capacity, some improvement that would be noticeable when compared to 2013 baseline conditions are not just in terms of reduction in delay but also the increase in the number of vehicles serviced when compared to the demand and reduction in queues at majority of the movements as summarized in **Table 25**.

Along the Seminary Road westbound approach at the intersections of Seminary Rd / N. Beauregard St, the occurrence of left turning vehicles spilling back and blocking the through lanes, possibly placing a constraint for the Seminary Road westbound approach upstream past Mark Center Drive and trips from I-395 ramps intending to merge onto Seminary Road westbound approach would still occur but the number of vehicles being serviced along the Seminary Road westbound approach would increase. Also for the Seminary Road westbound approach at the intersection of Seminary Rd / Mark Center Dr, left turn lane demand would exceed capacity, and left turn vehicles may block the through lanes and would still spill back, impacting the operations of the through lanes.

Even with the increase in the vehicles that would be serviced, since the tested Concept 1 would still not be able to service all the project demand volumes, and the fact that some of the critical intersections would still operate over capacity, additional improvement measures were evaluated under Concept 1. These included adding additional left turn lanes along the Seminary Rd westbound approach at Seminary Rd/Beauregard St intersection and along the N. Beauregard St southbound approach at Beauregard St/Mark Center Dr intersection in order to provide additional capacity for the heavy left-turn demand volume. **Table 26** presents the MOEs results from VISSIM for the critical intersections for Conceptual Alternative 1 with these improvements during weekday AM peak hour conditions.

Table 26: 2013 AM Conditions with Concept 1 Additional Left Turn Improvement - VISSIM MOEs

AM Operations			2013 Concept 1 without Stop Sign at the new ramp and with Additional left turn							
			Demand	Throughput	Throughput VS Demand	Delay (s)	Ave Queue (ft)	Max Queue (ft)	Ave Intersection Delay (s)	LOS
Seminary Rd & N. Beauregard St	Seminary Rd EB	LT	60	53	-7	114.0	20.7	128.9	78.4	E
		Thru	1,275	1,197	-78	103.3	736.3	1214.6		
		RT	180	169	-11	55.3	426.4	862.8		
	Seminary Rd WB	LT	850	834	-16	109.3	201.1	586.9		
		Thru	1,155	1,120	-35	20.0	73.9	642.3		
		RT	190	181	-9	8.0	7.1	322.3		
	N. Beauregard St NB	LT	465	444	-21	158.2	456.0	746.5		
		Thru	475	489	14	77.9	292.9	745.2		
		RT	305	307	2	50.5	129.0	372.7		
	N. Beauregard St SB	LT	145	152	7	104.4	78.2	286.4		
		Thru	195	207	12	57.4	36.5	176.5		
		RT	40	42	2	34.1	0.2	18.4		
N. Beauregard St & Mark Center Dr	N. Beauregard St NB	LT	50	53	3	74.4	18.9	135.2	53.8	D
		Thru	1,205	1,217	12	72.2	169.0	730.7		
		RT	440	450	10	37.3	37.5	421.4		
	N. Beauregard St SB	LT	710	701	-9	65.9	215.6	602.9		
		Thru	430	424	-6	3.2	1.8	78.1		
		RT	80	73	-7	2.2	58.1	353.0		
	Mark Center Dr EB	LT	10	9	-1	99.3	5.7	41.5		
		Thru	5	6	1	77.2	5.7	41.5		
		RT	5	5	0	62.0	5.7	41.5		
	Mark Center Dr WB	LT	35	48	13	68.4	20.2	129.7		
		Thru	5	5	0	64.0	20.2	129.7		
		RT	20	32	12	30.1	20.2	129.7		
Seminary Rd & Mark Center Dr	Seminary Rd EB	LT	20	17	-3	68.2	5.8	64.3	43.4	D
		Thru	1,350	1,271	-79	35.1	209.7	822.1		
		RT	360	341	-19	10.7	70.4	516.0		
	Seminary Rd WB	LT	465	433	-32	62.1	990.0	1477.7		
		Thru	2,110	2,050	-60	35.3	1004.9	1476.1		
		RT	90	87	-3	29.7	420.2	1180.9		
	Marc Center Dr NB	LT	35	38	3	69.4	24.6	121.7		
		Thru	15	17	2	63.7	24.6	121.7		
		RT	200	205	5	16.2	0.1	15.8		
	Marc Center Dr SB	LT	235	222	-13	150.0	254.0	508.1		
		Thru	85	81	-4	178.8	254.0	508.1		
		RT	50	48	-2	56.8	254.0	508.1		
I-395 SB On- Ramp & Seminary Rd	I-395 SB On- Ramp	LT	310	293	-17	1.8	9.5	168.8	49.8	D
		Thru	735	741	6	6.2	11.3	171.4		
	Seminary Rd WB	Thru	885	844	-41	109.5	417.2	978.0		
		RT	495	467	-28	41.4	148.0	612.5		
I-395 NB Off- Ramp & Seminary Rd	I-395 NB Off- Ramp	Thru	1090	1137	47	65.8	342.3	816.0	34.0	C
		RT	230	229	-1	26.1	365.7	844.2		
	Seminary Rd WB	LT	795	752	-43	2.0	11.6	88.2		
		Thru	395	373	-22	6.6	11.6	88.2		
I-395 NB On- Ramp & Seminary Rd	I-395 NB On- Ramp	LT	1020	1073	53	4.0	3.5	184.1	26.3	C
		Thru	870	817	-53	1.6	3.5	184.1		
	Seminary Rd EB	Thru	455	422	-33	122.9	337.9	692.8		
		RT	715	645	-70	31.6	152.9	479.5		
I-395 SB Off- Ramp & Seminary Rd	I-395 SB Off- Ramp	Thru	500	491	-9	121.8	206.0	772.6	56.3	E
		RT	600	571	-29	114.8	227.1	722.0		
	Seminary Rd EB	LT	545	545	0	1.3	1.8	152.1		
		Thru	815	838	23	13.6	1.8	152.1		

With the addition of left turn lanes, all the critical intersections are anticipated to operate at or under capacity during the AM peak hour conditions. At the Seminary Rd / N. Beauregard St intersection, LOS F (with delay of 118.4 sec/veh) for 2013 baseline condition would be improved to LOS E (with delay of 78.4 sec/veh) and LOS F (with delay of 118.4 sec/veh) for 2013 baseline condition would be improved to LOS D (with delay of 53.8 sec/veh) at N. Beauregard St / Mark Center Dr intersection. Also, a significant reduction in delay is anticipated at Seminary Rd / Mark Center Dr intersection where LOS F (with delay of 95.6 sec/veh) for 2013 baseline condition would be improved to LOS D (with delay of 43.4 sec/veh). Also, operations at the intersections with the I-395 ramps would generally operate similar to or improve when compared to the 2013 baseline conditions with most noticeable reduction in delay expected at I-395 southbound off-ramp intersections with Seminary Road. In addition, with the addition of left turn lanes for Concept 1, a majority of demand volume would be serviced with reduction in delay and in queues lengths as summarized in **Table 26**.

It would be important to note that although this analysis assumed no constraints to be placed at the access gates, depending on the processing time required to clear the vehicles at the security check point at the entrance to the south parking garage during the actual situation, in case the queues form which spill back to I-395 ramps, significant deterioration of operations along the I-395 southbound on ramp and the Seminary Rd eastbound approach would be anticipated.

6.4. 2013 Conditions with New Ramp to Mark Center (Concept 2)

The same parameters assumed in the 2013 baseline conditions analysis were used to analyze the Conceptual Alternative 1A2i using the VISSIM micro-simulation analysis. Conceptual Alternative 2 provides a direct ramp connection from I-395 southbound on ramp to the existing internal circulation roadways within Mark Center which would serve all the tenants to the Mark Center. **Table 27** presents the MOE results from VISSIM for the signalized intersections for Conceptual Alternative 2 during the weekday AM peak hour conditions within the study area.

Table 27: 2013 AM Conditions with Concept 2 Key Signalized Intersection - VISSIM MOEs

AM Operations			2013 Concept 2 without Stop Sign at the new ramp and without Additional left turn							
			Demand	Throughput	Throughput VS Demand	Delay (s)	Ave Queue (ft)	Max Queue (ft)	Ave Intersection Delay (s)	LOS
Seminary Rd & N. Beauregard St	Seminary Rd EB	LT	60	55	-5	83.1	21.3	126.5	51.8	D
		Thru	1,275	1,249	-26	54.2	286.5	991.6		
		RT	180	191	11	17.9	81.2	639.8		
	Seminary Rd WB	LT	425	437	12	93.8	133.1	645.2		
		Thru	1,155	1,103	-52	20.0	66.7	524.7		
		RT	190	177	-13	7.5	3.6	305.0		
	N. Beauregard St NB	LT	465	455	-10	122.6	303.6	708.6		
		Thru	475	485	10	60.1	122.4	628.1		
		RT	305	312	7	12.4	49.3	340.5		
	N. Beauregard St SB	LT	145	149	4	77.2	63.5	255.7		
Thru		195	206	11	48.5	34.7	153.4			
RT		40	43	3	30.5	0.0	0.0			
N. Beauregard St & Mark Center Dr	N. Beauregard St NB	LT	50	53	3	8.8	1.2	48.7	22.6	C
		Thru	1,205	1,225	20	26.4	53.9	443.5		
		RT	440	451	11	14.5	1.3	134.2		
	N. Beauregard St SB	LT	285	300	15	49.3	73.7	392.1		
		Thru	430	448	18	1.3	3.2	107.0		
		RT	80	85	5	3.2	4.6	206.9		
	Mark Center Dr EB	LT	10	9	-1	91.4	5.9	42.5		
		Thru	5	6	1	66.2	5.9	42.5		
		RT	5	5	0	65.0	5.9	42.5		
	Mark Center Dr WB	LT	35	45	10	70.5	18.5	120.0		
		Thru	5	4	-1	70.3	18.5	120.0		
		RT	20	32	12	8.7	18.5	120.0		
Seminary Rd & Mark Center Dr	Seminary Rd EB	LT	20	18	-2	74.7	6.8	66.3	31.9	C
		Thru	1,350	1,337	-13	16.8	56.7	408.8		
		RT	360	356	-4	2.9	3.0	189.6		
	Seminary Rd WB	LT	450	387	-63	77.0	240.2	971.8		
		Thru	1,685	1,613	-72	24.3	156.7	987.7		
		RT	90	81	-9	21.7	36.7	692.5		
	Marc Center Dr NB	LT	35	37	2	74.5	22.6	106.5		
		Thru	15	19	4	73.9	22.6	106.5		
		RT	175	179	4	4.8	0.0	0.0		
	Marc Center Dr SB	LT	235	222	-13	119.6	216.7	480.6		
Thru		85	80	-5	146.4	216.7	480.6			
RT		50	51	1	22.3	216.7	480.6			
I-395 SB On- Ramp & Seminary Rd	I-395 SB On- Ramp	LT	310	272	-38	3.4	35.8	274.4	33.9	C
		Thru	1175	1155	-20	9.7	36.9	276.1		
	Seminary Rd WB	Thru	885	869	-16	75.4	185.4	588.9		
		RT	455	441	-14	34.6	185.4	588.9		
I-395 NB Off- Ramp & Seminary Rd	I-395 NB Off- Ramp	Thru	1090	1146	56	65.6	317.8	793.7	36.9	D
		RT	230	232	2	32.0	341.2	822.2		
	Seminary Rd WB	LT	795	783	-12	4.0	44.3	221.6		
		Thru	395	357	-38	20.4	44.3	221.6		
I-395 NB On- Ramp & Seminary Rd	I-395 NB On- Ramp	LT	1020	1077	57	4.2	7.7	270.6	37.1	D
		Thru	870	852	-18	1.9	7.7	270.6		
	Seminary Rd EB	Thru	470	409	-61	186.6	481.6	677.9		
		RT	715	595	-120	44.2	238.5	464.3		
I-395 SB Off- Ramp & Seminary Rd	I-395 SB Off- Ramp	Thru	710	699	-11	170.9	793.3	1320.0	59.3	E
		RT	395	390	-5	58.6	322.1	825.1		
	Seminary Rd EB	LT	780	730	-50	2.1	3.6	165.7		
		Thru	600	653	53	4.3	3.6	165.7		

The new direct ramp connection to the Mark Center internal roadways was assumed, but without additional left turn lanes along the Seminary Rd westbound approach at Seminary Rd/Beauregard St intersection and along the N. Beauregard St southbound approach at Beauregard St/Mark Center Dr intersection. It was also assumed also that there would be no constraints along the access to the Mark Center internal roadways and additional measures would be taken within the Mark Center site to prevent vehicle from spilling back to I-395 ramps.

Under this concept, all of the critical intersections are anticipated to operate at or under capacity during AM peak hour conditions, with a majority of demand volume being serviced with reductions in delay and queues lengths as summarized in **Table 27**. At the Seminary Rd / N. Beauregard St intersection, LOS F (with delay of 118.4 sec/veh) for 2013 baseline condition would be improved to LOS D (with delay of 51.8 sec/veh) and LOS F (with delay of 118.4 sec/veh) for 2013 baseline condition would be improved to LOS C (with delay of 22.6 sec/veh) at N. Beauregard St / Mark Center Dr intersection. Also, significant reduction in delay is anticipated at the Seminary Rd / Mark Center Dr intersection where LOS F (with delay of 95.6 sec/veh) for 2013 baseline condition would be improved to LOS C (with delay of 31.9 sec/veh). Also, operations at the intersections with the I-395 ramps would improve when compared to the 2013 baseline conditions with most noticeable reduction in delay expected at I-395 southbound off-ramp intersections with Seminary Road.

VISSIM analysis for Concept 2 was also performed for PM peak hour conditions since Concept 2 would be expected to yield the highest diversion of the project trips among the alternatives tested. This was done in order to evaluate the operational impacts that the egress trips from the direct access ramps would have to the I-395 southbound on ramps along with the impact to the traffic operations at the intersections vicinity to the project site. Also, the impact of constructing the direct access ramp, which would require the intersection of I-395 SB On-Ramp / Seminary Rd to be reconfigured from the existing right turn channelized lanes has been simulated.

As shown in **Table 28**, all the critical intersections are anticipated to operate at or under capacity during the PM peak hour conditions except at I-395 southbound off-ramp intersections with Seminary Road. At the Seminary Rd / N. Beauregard St intersection, LOS E (with delay of 69.8 sec/veh) for 2013 baseline condition would be improved to LOS D (with delay of 52.8 sec/veh) and LOS C (with delay of 34.6 sec/veh) for 2013 baseline condition would be improved to LOS B (with delay of 19.1 sec/veh) at

N. Beauregard St / Mark Center Dr intersection. Also, a minor reduction in delay is anticipated at the Seminary Rd / Mark Center Dr intersection where LOS D is maintained but delay of 51.8 sec/veh for 2013 baseline condition would be reduced to delay of 49.7 sec/veh. Also, operations at the intersections with the I-395 ramps would generally improve when compared to the 2013 baseline conditions with higher number of serviced vehicles when compared to demand. The most noticeable reduction in delay expected at I-395 southbound off-ramp intersections with Seminary Road. Under Concept 2 for PM conditions, a majority of demand volume would be serviced with reduction in delay and in queues lengths except that the project trips intending to exit from the Mark Center Dr northbound right turn maneuver would not be fully serviced due to the heavy volumes.

Therefore, similar to the capacity analysis findings for this alternative, the micro-simulation results suggest that Conceptual Alternative 2 is anticipated to improve the overall operational performance when compared to Conceptual Alternative 1 and 2013 Baseline Conditions, most notably during weekday morning peak hour conditions. However, similar to Concept 1, it would be important to note that although this analysis assumed no constraints to be placed at the connection to the Mark Center internal roadways, depending on the constraints such as placing a stop signs at immediate vicinity to the access roadways without providing the sufficient storage length of the vehicles would potentially result in queues being formed which would spill back to I-395 ramps. Since the spacing between the evaluated ramp access and the intersection of I-395 southbound on ramp / Seminary Rd would be only spaced 270 feet apart (which is a very short distance to place an access point), in case of any queues from the access road spilling back into the I-395 southbound ramps, significant deterioration of operations along the I-395 southbound on ramp and the Seminary Rd eastbound approach would be anticipated due to the heavy weaving maneuver that would be anticipated to occur along the short distance.

Table 28: 2013 PM Conditions with Concept 2 Key Signalized Intersection - VISSIM MOEs

PM Operations			2013 Concept 2							
			Demand	Throughput	Throughput VS Demand	Delay (s)	Ave Queue (ft)	Max Queue (ft)	Ave Intersection Delay (s)	LOS
Seminary Rd & N. Beauregard St	Seminary Rd EB	LT	110	114	4	93.7	147.2	1214.7	52.8	D
		Thru	1,255	1,238	-17	62.1	512.1	1226.3		
		RT	535	547	12	35.5	284.1	874.5		
	Seminary Rd WB	LT	450	412	-38	73.9	85.4	335.1		
		Thru	1,315	1,177	-138	31.9	107.6	519.8		
		RT	250	226	-24	13.7	8.2	271.0		
	N. Beauregard St NB	LT	385	372	-13	130.9	242.6	579.0		
		Thru	435	432	-3	56.4	118.5	580.3		
		RT	345	349	4	3.4	46.7	205.1		
	N. Beauregard St SB	LT	155	150	-5	56.9	47.7	231.6		
		Thru	440	452	12	61.5	88.5	314.9		
		RT	45	52	7	57.1	0.1	21.7		
N. Beauregard St & Mark Center Dr	N. Beauregard St NB	LT	5	7	2	13.8	0.3	15.7	19.1	B
		Thru	950	978	28	19.2	29.6	282.9		
		RT	55	58	3	9.3	0.0	9.8		
	N. Beauregard St SB	LT	45	50	5	11.5	1.2	43.4		
		Thru	1,370	1,346	-24	11.0	81.7	726.9		
		RT	15	17	2	11.8	27.5	493.6		
	Mark Center Dr EB	LT	70	73	3	54.2	20.0	129.4		
		Thru	20	18	-2	31.2	20.0	129.4		
		RT	30	25	-5	33.6	20.0	129.4		
	Mark Center Dr WB	LT	370	317	-53	48.2	95.5	504.9		
		Thru	5	3	-2	69.5	95.5	504.9		
		RT	140	125	-15	14.6	95.5	504.9		
Seminary Rd & Mark Center Dr	Seminary Rd EB	LT	35	38	3	89.8	17.5	148.3	49.7	D
		Thru	1,655	1,630	-25	23.0	104.0	519.6		
		RT	65	67	2	2.9	8.7	290.3		
	Seminary Rd WB	LT	150	157	7	81.7	597.2	1468.8		
		Thru	1,565	1,516	-49	62.5	715.6	1467.2		
		RT	105	93	-12	54.8	296.5	1172.0		
	Marc Center Dr NB	LT	365	229	-136	90.7	335.1	385.9		
		Thru	85	56	-29	87.6	335.1	385.9		
		RT	990	677	-313	59.7	335.1	385.9		
	Marc Center Dr SB	LT	190	179	-11	74.4	74.9	275.1		
		Thru	15	18	3	73.3	74.9	275.1		
		RT	70	72	2	7.0	74.9	275.1		
I-395 SB On- Ramp & Seminary Rd	I-395 SB On- Ramp	LT	710	693	-17	4.0	8.6	277.9	32.7	C
		Thru	365	421	56	4.5	11.4	280.5		
	Seminary Rd WB	Thru	1110	979	-131	74.2	201.4	921.6		
		RT	910	781	-129	21.3	201.4	921.6		
I-395 NB Off- Ramp & Seminary Rd	I-395 NB Off- Ramp	Thru	795	820	25	57.4	259.7	725.1	29.8	C
		RT	390	402	12	63.7	295.4	767.1		
	Seminary Rd WB	LT	820	712	-108	3.2	49.0	294.6		
		Thru	1000	962	-38	11.7	49.0	294.6		
I-395 NB On- Ramp & Seminary Rd	I-395 NB On- Ramp	LT	625	646	21	1.8	0.9	90.7	18.1	B
		Thru	990	884	-106	1.1	0.9	90.7		
	Seminary Rd EB	Thru	340	323	-17	105.2	173.1	487.3		
		RT	360	340	-20	10.5	21.3	274.0		
I-395 SB Off- Ramp & Seminary Rd	I-395 SB Off- Ramp	Thru	705	710	5	185.2	616.1	1173.7	81.9	F
		RT	410	395	-15	76.9	189.0	679.2		
	Seminary Rd EB	LT	370	408	38	4.9	12.3	222.2		
		Thru	670	636	-34	19.3	12.3	222.2		

6.5. 2013 Conditions with Additional left Turn Lanes without No New Ramp (Concept 4)

The same parameters assumed in the 2013 Baseline Conditions were used to analyze the Conceptual Alternative 4 using VISSIM micro-simulation analysis. Conceptual Alternative 4 provides additional capacity for the left turn lanes at the following critical approaches without any direct ramp connection from and to I-395 southbound off ramp.

- Seminary Rd / N.Beauregard St intersection – addition of a westbound left-turn lane along Seminary Rd to improve this approach from a dual to triple left turn lane configuration.
- N.Beauregard St / Mark Center Dr intersection - addition of a southbound left-turn lane along N.Beauregard St to improve this approach from a single to a dual left turn lane configuration.

Table 29 presents the MOEs from VISSIM for the critical intersections for Conceptual Alternative 4 during the weekday morning peak hour conditions within the study area. The intersections of N. Beauregard St / Mark Center Dr, and I-395 southbound off-ramp intersection with Seminary Rd are anticipated to operate above capacity during the AM peak hour conditions, mainly due to heavy traffic volume along westbound Seminary Rd with the addition of the project trips, but the delay would be further reduced when compared to 2013 baseline conditions. At the intersections of Seminary Rd / N. Beauregard St compared to the 2013 Baseline conditions, LOS F (with delay of 101.8 sec/veh) for 2013 baseline condition would be improved to LOS E (with delay of 78.2 sec/veh) at the Seminary Rd / N. Beauregard St intersection and LOS F (with delay of 118.4 sec/veh) for 2013 baseline condition would be improved to LOS F (with delay of 96.4 sec/veh) at N. Beauregard St / Mark Center Dr intersection. Significant reduction in delay is anticipated at Seminary Rd / Mark Center Dr intersection where LOS F (with delay of 95.6 sec/veh) for 2013 baseline condition would be improved to LOS D (with delay of 48.1 sec/veh). Also, operations at some of the intersections with the I-395 ramps would generally be in the similar range or improve when compared to the 2013 baseline conditions with a noticeable reduction in delay expected at I-395 southbound and northbound off-ramp intersections with Seminary Road.

Although critical intersections such as Seminary Rd / N. Beauregard St and Seminary Rd / Mark Center Dr would operate under capacity, the micro-simulation results show that a significant number of trips would not be serviced under this concept along the Seminary Road westbound approach and I-395 southbound and northbound off-ramp mainly due to the constraint that would occur downstream.

Along the Seminary Road westbound approach at the intersections of Seminary Rd / N. Beauregard St, the occurrence of left turning vehicles spilling back and blocking the through lanes, possibly placing a constraint for the Seminary Road westbound approach upstream past Mark Center Drive and trips from I-395 ramps intending to merge onto Seminary Road westbound approach would be somewhat improved and the number of vehicles being serviced along the Seminary Road westbound approach would increase compared to 2013 baseline conditions. For the Seminary Road westbound approach at the intersection of Seminary Rd / Mark Center Dr, left turn lane demand would possibly exceed the capacity, and left turn vehicles may block through lanes and would spill back impacting the operations of the through lanes. Also, along the N Beauregard Street southbound approach at the intersection of N. Beauregard St / Mark Center Dr, with the additional lane widening and left turn lane, the traffic flows would improve but the left turn lane storage length would not still be long enough, resulting in some left turn vehicles blocking the through lanes.

However, even with the increase in the vehicles that would be serviced compared to 2013 baseline conditions, since the evaluated Concept 4 would still not be able to service all the demand, and the fact that some of the critical intersections would still operate over capacity, additional improvement measures would need to be considered such as providing direct access ramps in combination with adding the additional left turn lanes along the Seminary Rd westbound approach at Seminary Rd/Beauregard St intersection and along the N. Beauregard St southbound approach at Beauregard St/Mark Center Dr intersection in order to provide additional access points to the project site so that the project trips can be diverted to different access points.

Table 29: 2013 AM Conditions with Concept 4 Key Signalized Intersection - VISSIM MOEs

AM Operations			2013 Concept 4								LOS
			Demand	Throughput	Throughput VS Demand	Delay (s)	Ave Queue (ft)	Max Queue (ft)	Ave Intersection Delay (s)		
Seminary Rd & N. Beauregard St	Seminary Rd EB	LT	60	48	-12	123.3	16.5	103.5	78.2	E	
		Thru	1,275	1,088	-187	125.8	992.1	1228.2			
		RT	180	145	-35	85.1	646.7	876.4			
	Seminary Rd WB	LT	1,295	1,009	-286	49.6	244.4	742.4			
		Thru	1,155	948	-207	22.5	71.1	595.7			
		RT	190	146	-44	8.6	101.3	397.5			
	N. Beauregard St NB	LT	465	403	-62	8.7	122.9	406.7			
		Thru	475	419	-56	197.9	462.1	780.6			
		RT	305	271	-34	140.8	365.2	751.3			
	N. Beauregard St SB	LT	145	146	1	83.9	68.6	265.9			
Thru		195	211	16	73.1	37.0	166.1				
RT		40	41	1	29.3	0.0	11.4				
N. Beauregard St & Mark Center Dr	N. Beauregard St NB	LT	50	47	-3	115.4	4.8	61.3	96.4	F	
		Thru	1,205	1,068	-137	171.3	1291.6	1673.9			
		RT	440	375	-65	120.2	1132.9	1666.1			
	N. Beauregard St SB	LT	1,155	949	-206	45.9	308.6	809.6			
		Thru	430	337	-93	5.5	3.4	93.2			
		RT	80	64	-16	3.7	153.4	559.0			
	Mark Center Dr EB	LT	10	12	2	28.1	1.5	27.1			
		Thru	5	5	0	9.8	1.5	27.1			
		RT	5	3	-2	76.9	1.5	27.1			
	Mark Center Dr WB	LT	35	44	9	72.2	17.2	94.0			
		Thru	5	12	7	21.7	17.2	94.0			
		RT	20	28	8	26.0	17.2	94.0			
Seminary Rd & Mark Center Dr	Seminary Rd EB	LT	20	17	-3	62.8	5.4	68.7	48.1	D	
		Thru	1,350	1,178	-172	25.4	74.2	292.9			
		RT	360	315	-45	2.8	2.5	205.6			
	Seminary Rd WB	LT	530	505	-25	78.8	1360.0	1483.8			
		Thru	2,555	2,021	-534	53.8	1349.8	1482.2			
		RT	90	73	-17	42.4	592.7	1186.9			
	Marc Center Dr NB	LT	35	32	-3	77.2	15.9	123.9			
		Thru	15	10	-5	72.2	15.9	123.9			
		RT	220	202	-18	6.0	0.0	25.1			
	Marc Center Dr SB	LT	235	225	-10	112.0	202.5	455.3			
		Thru	85	83	-2	136.8	202.5	455.3			
		RT	50	50	0	36.8	202.5	455.3			
I-395 SB On- Ramp & Seminary Rd	I-395 SB On- Ramp	LT	310	150	-160	1.3	0.0	0.0	43.9	D	
		Thru	225	214	-11	0.7	0.0	0.0			
	Seminary Rd WB	Thru	885	781	-104	81.5	189.1	723.8			
		RT	515	454	-61	13.7	21.4	358.6			
I-395 NB Off- Ramp & Seminary Rd	I-395 NB Off- Ramp	Thru	1090	1110	20	57.8	307.2	738.7	33.4	C	
		RT	230	245	15	27.0	335.8	775.0			
	Seminary Rd WB	LT	795	699	-96	4.0	15.3	116.2			
		Thru	395	232	-163	12.2	15.3	116.2			
I-395 NB On- Ramp & Seminary Rd	I-395 NB On- Ramp	LT	1020	1035	15	6.4	30.1	340.2	22.4	C	
		Thru	870	770	-100	4.6	30.1	340.2			
	Seminary Rd EB	Thru	390	384	-6	105.5	220.1	674.5			
		RT	715	710	-5	19.9	63.6	461.1			
I-395 SB Off- Ramp & Seminary Rd	I-395 SB Off- Ramp	Thru	265	99	-166	273.1	18.4	120.3	119.1	F	
		RT	835	291	-544	470.4	717.6	748.0			
	Seminary Rd EB	LT	270	265	-5	2.0	22.6	243.6			
		Thru	1025	1045	20	36.4	22.6	243.6			

7. Interim Solution for the Period between 2011 and 2013

The construction and occupancy of the BRAC 133 site is anticipated to be completed by 2011. Although the analysis reveals that the construction of a new direct access ramp to the project site will improve the operations at the critical intersections located in the vicinity of the project site during both morning and evening peak periods, it will not be until year 2013 at the earliest that the direct ramp would be in operations. Therefore, interim solutions would need to be identified in order to accommodate the project trips for the periods from BRAC occupancy anticipated by 2011 and the anticipated construction of the new ramp by 2013. This section identifies and evaluates potential interim solutions to be implemented between these time periods.

7.1. 2011 Baseline Conditions with BRAC Occupancy

Traffic projections for 2011 baseline condition assuming BRAC occupancy without the new direct access ramp were developed by first applying initially 0.5% growth per year to the existing volume and then assigning the BRAC 133 and IDA 5 generated project trips. It was assumed for year 2011 that IDA 5 expansion would occur only for the first phase with only one additional building being constructed while BRAC 133 project site would be fully built out. **Table 30** summarizes the trip generation assumed for the 2011 baseline conditions

Table 30: 2011 Baseline Condition Trip Generation

	AM Peak Hour			PM Peak Hour		
	In	Out	Total	In	Out	Total
BRAC 133	1,195	79	1,274	148	1,195	1,343
IDA Building 5	228	31	259	42	205	247
Additional Project Trips Occupying the Available 273 Parking Spaces (40% during peak hour)	110	0	110	0	110	110
Total	1,533	110	1,643	190	1,510	1,700

The established project trips were then distributed according to the same trip distribution assumed for the 2013 conditions and **Figure 11** depicts the turning movement volumes established at the study intersections after assigning the project trips onto the baseline condition.

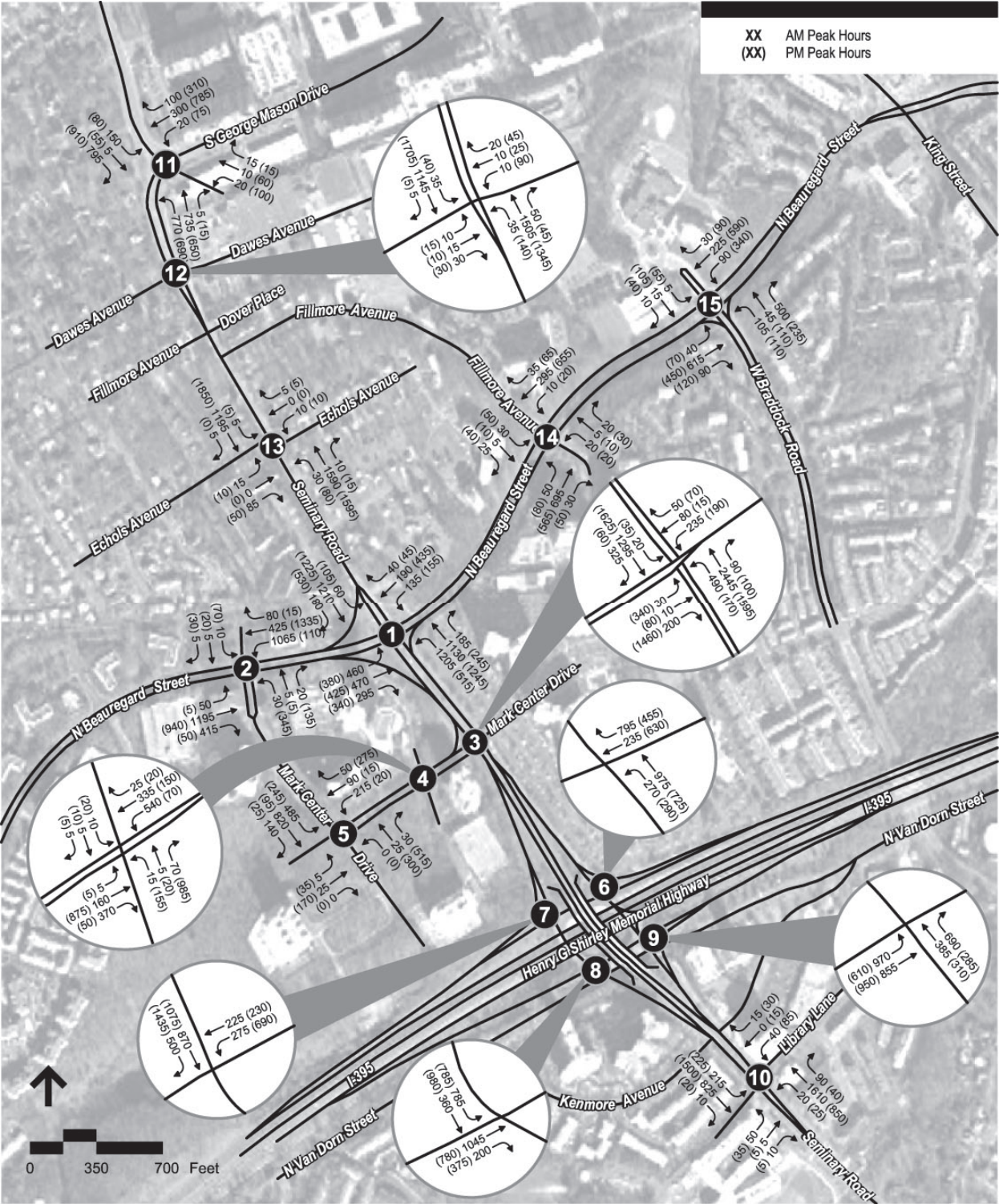


Figure 11: 2011 Baseline Condition with BRAC Occupancy Peak Hour Volumes

7.2. Traffic Operations

Using the turning movement volumes developed for the future baseline condition, a traffic operational analysis for the study intersections was performed initially using Synchro analysis software. Similar to the procedure followed for the 2013 baseline conditions, signal timings at the study intersections were optimized accounting the project volumes. Also, in order to provide additional capacity for the through and left turn movement at the already failing intersections with I-395 ramps, improvement measures such as restriping the lane marking which includes converting the northbound right turn lane into shared through and right turn lane at the I-395 NB Off-ramp / Seminary Rd intersection and also converting the northbound through lane into shared left turn and through lane at the I-395 NB On-ramp / Seminary Rd intersection were assumed.

Table 31 presents the Measures of Effectiveness (MOEs) for the study intersections under the 2011 baseline weekday morning and evening peak hour conditions within the study area. As shown in the table, operations at all of the intersections are expected to deteriorate in year 2011 for morning and evening time periods since the BRAC 133 site would be fully built out with the added project traffic volumes. During AM peak hour conditions, due to the addition of project trips accessing the project site, the Seminary Rd / N. Beauregard St and N. Beauregard St / Mark Center Dr intersections would operate over capacity with LOS F. During evening peak hour conditions, the Seminary Rd / Mark Center Dr and Mark Center Dr / Hilton / CNAC Dr intersections are also expected to operate over capacity with LOS F mainly due to the heavy project trips exiting the project site via these intersections. The Seminary Rd / George Mason Dr intersection is also expected to continue operating above capacity with LOS F. All of the remaining study intersections would operate at LOS D or better during weekday morning and evening peak hour conditions.

Table 31: 2011 Baseline Condition MOEs with BRAC Occupancy without Improvement

No.	Intersection Location	Control Type	2011 Baseline AM Peak Hour Condition			2011 Baseline PM Peak Hour Condition		
			V/C	LOS	Delay (sec/veh)	V/C	LOS	Delay (sec/veh)
1	Seminary Rd / N. Beauregard St	Signal	1.06	F	105.1	0.91	D	46.5
	Eastbound			F	124.8		C	29.0
	Westbound			F	96.9		D	40.8
	Northbound			F	110.1		E	65.7
	Southbound			E	66.2		E	72.8
2	N. Beauregard St / Mark Center Dr	Signal	1.25	F	93.0	0.82	C	26.5
	Eastbound			E	63.5		C	28.6
	Westbound			E	65.3		D	52.1
	Northbound			D	48.6		C	22.8
	Southbound			F	141.3		C	20.5
3	Seminary Rd / Mark Center Dr	Signal	0.80	C	27.2	1.08	F	85.8
	Eastbound			B	16.0		D	35.0
	Westbound			C	27.1		C	28.6
	Northbound			D	37.1		F	193.5
	Southbound			E	72.5		E	55.1
4	Mark Center Dr / Hilton / CNAC Dr	Stop Sign		B	14.1		F	Err
	Eastbound			A	0.1		A	0.1
	Westbound			A	9.7		A	3.6
	Northbound			F	85.4		F	Err
	Southbound			F	261.9		F	117.6
5	Mark Center Dr / IDA Dr	Signal	0.62	B	10.3	0.46	B	12.2
	Eastbound			A	8.2		A	4.5
	Westbound			B	19.4		B	13.2
	Northbound			B	13.7		B	16.7
	Southbound			B	16.8		B	15.5
6	I-395 SB Off-ramp / Seminary Rd	Signal	0.52	A	9.6	0.53	C	28.5
	Southbound (I-395 SB Off-ramp)			B	16.1		D	49.2
	Westbound			A	4.2		A	6.2
7	I-395 SB On-ramp / Seminary Rd	Signal	0.43	C	28.7	0.94	C	28.5
	Southbound			A	3.1		A	2.3
	Eastbound (I-395 SB On-ramp)			D	38.1		D	38.1
8	I-395 NB Off-ramp / Seminary Rd	Signal	0.65	C	28.4	0.75	C	33.3
	Northbound (I-395 NB Off-ramp)			D	51.3		E	78.4
	Eastbound			A	3.4		A	3.9
9	I-395 NB On-ramp / Seminary Rd	Signal	0.53	B	11.3	0.44	B	11.9
	Northbound			A	1.3		A	2.0
	Westbound (I-395 NB On-ramp)			C	28.3		D	37.9
10	Seminary Rd / Library Ln	Signal	0.71	B	12.8	0.68	B	15.2
	Eastbound			A	9.1		B	10.8
	Westbound			B	11.2		B	14.7
	Northbound			E	75.9		D	45.0
	Southbound			E	60.7		E	68.0

Note: Results are from the HCM module in Synchro.

No.	Intersection Location	Control Type	2011 Baseline AM Peak Hour Condition			2011 Baseline PM Peak Hour Condition		
			V/C	LOS	Delay (sec/veh)	V/C	LOS	Delay (sec/veh)
11	Seminary Rd / George Mason Dr	Signal	0.52	C	31.2	1.03	F	100.6
	Eastbound (Seminary Rd)			C	24.8		F	81.5
	Westbound (Seminary Rd)			C	33.3		E	67.9
	Northbound (Shopping Plaza)			D	40.0		F	169.0
	Southbound (S George Mason Dr)			D	42.7		E	58.0
12	Seminary Rd / Dawes Ave	Signal	0.54	A	5.9	0.74	B	16.9
	Eastbound			A	4.6		B	15.5
	Westbound			A	3.2		B	13.0
	Northbound			E	65.8		D	49.5
	Southbound			E	64.9		E	57.3
13	Seminary Rd / Echols Ave	Signal	0.64	B	11.2	1.01	D	54.5
	Eastbound			A	8.5		B	10.7
	Westbound			A	9.4		F	102.4
	Northbound			E	66.0		E	57.0
	Southbound			E	68.3		E	58.2
14	N. Beauregard St / Fillmore Ave	Signal	0.28	B	11.6	0.35	B	13.3
	Eastbound			E	58.3		D	46.0
	Westbound			E	61.4		D	49.0
	Northbound			A	7.1		B	11.8
	Southbound			A	7.1		A	7.3
15	N. Beauregard St / W Braddock Rd	Signal	0.33	C	34.6	0.49	C	34.4
	Eastbound			E	65.4		D	53.6
	Westbound			E	64.7		E	55.3
	Northbound			B	11.2		C	22.8
	Southbound			C	25.8		C	28.7

Note: Results are from the HCM module in Synchro.

7.3. Interim Improvement Solutions

When excluding the option of constructing the direct access ramp to the project site or providing additional left turn lanes at the critical intersection serving the site, other improvement measures that can be considered are very limited due to the ROW constraints and a lack of other access points available to divert the trips accessing Mark Center.

A feasible interim option tested in this section was to increase, within existing ROW, the left turn bay storage length along westbound Seminary Rd to accommodate the critical left turn volume at the intersections of Seminary Rd / N. Beauregard St and Seminary Rd / Mark Center Dr. The details of the evaluated interim improvements are as follows:

- At the intersection of Seminary Rd / N. Beauregard St : Increase westbound Seminary Rd left turn storage length from 250 ft to 390 ft.
- At the intersection of Seminary Rd / Mark Center Dr : Increase westbound Seminary Rd left turn storage length from 210 ft to 500 ft

To evaluate the operational benefits of increasing storage length at these intersections, a detail VISSIM micro simulation analysis was performed since there were limitations in assessing the effect of changes to the storage length with Synchro analysis. Therefore, the 2011 baseline condition and this alternative concept, which assumed increased storage length, were both modeled in the VISSIM simulation model to assess the operational benefits. Weekday morning peak hour conditions were modeled since this was the time period when the critical intersections would operate over capacity. **Table 32** presents the summary of Measures of Effectiveness (MOEs) from the VISSIM analysis for the 2011 baseline weekday morning peak hour conditions at the critical intersections within the study area. As shown in the **Table 32**, the MOE results shows that the operations at these intersections are expected to deteriorate due to the added project traffic volumes similar as the results obtained in Synchro. The intersections of Seminary Rd / N. Beauregard St, N. Beauregard St / Mark Center Dr, and Seminary Rd / Mark Center Dr are anticipated to operate over capacity (LOS F). Also, the intersection of I-395 SB Off-Ramp & Seminary Rd would operate over capacity due to the spill back and queue that would form along the ramp due to the bottleneck formed at Seminary Rd / Mark Center Dr for the traffic intending to merge along westbound Seminary Rd

Table 32: 2011 AM Baseline Condition - VISSIM Intersection MOEs

AM Operations			2011 Baseline without Improvement							LOS
			Demand	Throughput	Throughput VS Demand	Delay (s)	Ave Queue (ft)	Max Queue (ft)	Ave Intersection Delay (s)	
Seminary Rd & N. Beauregard St	Seminary Rd EB	LT	60	52	-8	141.7	16.2	115.6	97.9	F
		Thru	1,210	1,016	-194	146.5	1041.9	1224.9		
		RT	180	155	-25	110.3	692.0	873.1		
	Seminary Rd WB	LT	1,205	770	-435	111.6	496.1	765.8		
		Thru	1,130	788	-342	26.6	100.4	698.1		
		RT	185	126	-59	11.6	192.2	414.0		
	N. Beauregard St NB	LT	460	383	-77	222.1	524.1	790.9		
		Thru	470	403	-67	56.2	359.3	795.2		
		RT	295	256	-39	16.6	167.7	417.1		
	N. Beauregard St SB	LT	135	146	11	96.9	76.5	276.4		
		Thru	190	196	6	77.3	35.5	155.3		
		RT	40	41	1	27.8	0.5	24.1		
N. Beauregard St & Mark Center Dr	N. Beauregard St NB	LT	50	47	-3	115.2	1.9	45.1	111.9	F
		Thru	1,195	1,032	-163	199.2	1477.6	1673.8		
		RT	415	339	-76	130.8	1325.8	1574.5		
	N. Beauregard St SB	LT	1,065	768	-297	40.0	338.0	837.2		
		Thru	425	289	-136	5.0	1.1	64.3		
		RT	80	59	-21	5.3	158.2	583.3		
	Mark Center Dr EB	LT	10	10	0	119.9	5.4	41.5		
		Thru	5	6	1	52.8	5.4	41.5		
		RT	5	4	-1	3.9	0.0	0.0		
	Mark Center Dr WB	LT	30	36	6	75.7	17.1	104.2		
		Thru	5	9	4	64.4	17.1	104.2		
		RT	20	25	5	39.6	17.1	104.2		
Seminary Rd & Mark Center Dr	Seminary Rd EB	LT	20	15	-5	67.2	4.7	49.8	87.4	F
		Thru	1,295	1,115	-180	29.9	94.5	467.3		
		RT	325	286	-39	6.3	20.3	341.0		
	Seminary Rd WB	LT	490	362	-128	140.3	1452.7	1610.1		
		Thru	2,445	1,626	-819	110.6	1462.1	1609.9		
		RT	90	51	-39	85.5	791.7	1432.8		
	Marc Center Dr NB	LT	30	28	-2	95.5	14.8	93.1		
		Thru	10	11	1	80.6	14.8	93.1		
		RT	200	174	-26	5.4	0.0	0.0		
	Marc Center Dr SB	LT	235	211	-24	223.2	352.0	550.4		
		Thru	80	70	-10	257.6	352.0	550.4		
		RT	50	44	-6	191.5	352.0	550.4		
I-395 SB On- Ramp & Seminary Rd	I-395 SB On- Ramp	LT	275	58	-217	2.6	0.9	52.3	32.2	C
		Thru	225	190	-35	2.1	1.2	61.2		
	Seminary Rd WB	Thru	870	742	-128	57.5	129.1	622.2		
		RT	500	454	-46	7.1	8.7	256.7		
I-395 NB Off- Ramp & Seminary Rd	I-395 NB Off- Ramp	Thru	1045	1010	-35	160.2	966.9	1667.6	101.9	F
		RT	200	185	-15	112.8	985.8	1662.0		
	Seminary Rd WB	LT	785	669	-116	28.2	41.6	275.4		
		Thru	360	126	-234	10.2	41.6	275.4		
I-395 NB On- Ramp & Seminary Rd	I-395 NB On- Ramp	LT	970	930	-40	28.4	144.5	356.2	55.8	E
		Thru	855	741	-114	13.6	144.5	356.2		
	Seminary Rd EB	Thru	385	225	-160	320.3	541.4	693.2		
		RT	690	594	-96	51.2	333.8	479.8		
I-395 SB Off- Ramp & Seminary Rd	I-395 SB Off- Ramp	Thru	235	31	-204	638.1	6.9	72.2	189.1	F
		RT	795	59	-736	2424.9	724.6	753.7		
	Seminary Rd EB	LT	270	217	-53	9.0	134.8	320.6		
		Thru	975	928	-47	74.9	134.8	320.6		

The interim improvement concept with the increased the storage length at the left turn bays specified above were also analyzed in VISSIM and **Table 33** presents the summary of Measures of Effectiveness (MOEs) from the VISSIM analysis. Although the magnitude in reduction of delay would not be significant for all the intersections, the interim improvement with the additional storage length would increase the number of project trips being served, especially for the westbound left turn (78 more left turn volume) along Seminary Rd at Seminary Rd / N. Beauregard St intersection and the westbound left turn (37 more left turn volume) movement at N. Beauregard St / Mark Center Dr intersection. Therefore, by increasing the storage lane, additional capacity would be provided for the heavy project trips destined to the project site which will all be positioned at the left turn bay. In addition, the improvement would also be effective in terms of reducing the occurrences of the left turn vehicles spilling back into lanes dedicated for the through movement and would increase the throughput for the through movement.

Based on the VISSIM analysis results for the interim improvement concepts, increasing the storage length for the left turn bays bring some operational benefits in terms of reducing the delay, queue length at some intersections but the most notable benefit would be increasing the vehicles being served at these critical locations. It was found that at the intersection of Seminary Rd / Mark Center Dr, increasing westbound Seminary Rd left turn storage length from 210 ft to 500 ft would be most beneficial in terms of reducing the occurrences of left turning vehicles along Seminary Rd left turn storage lane spilling back onto the lanes dedicated for the through movement and therefore increasing the throughput for both the left turn and through movement by 146 vehicles along westbound Seminary Rd. Noting this fact, this improvement would be beneficial to all the other conceptual alternatives considered in 2013 most notably during AM peak period when the demand for the left turn would be the heaviest.

However, even with the increased throughput and reduction in delay obtainable with the interim improvement measures of increasing the left turn storage length at the intersections specified above, these interim measures are still not able to accommodate all the project demand and at the same time the critical intersection would still operate over capacity with LOS F at the intersections of Seminary Rd / N. Beauregard St and N. Beauregard St / Mark Center Dr.

Table 33: 2011 AM Baseline Condition with Improvement - VISSIM Intersection MOEs

AM Operations			2011 Baseline with Storage Lane Improvement							LOS
			Demand	Throughput	Throughput VS Demand	Delay (s)	Ave Queue (ft)	Max Queue (ft)	Ave Intersection Delay (s)	
Seminary Rd & N. Beauregard St	Seminary Rd EB	LT	60	47	-13	135.4	14.3	108.0	100.1	F
		Thru	1,210	970	-240	145.7	1056.9	1227.7		
		RT	180	140	-40	149.9	707.7	875.9		
	Seminary Rd WB	LT	1,205	848	-357	129.8	472.9	767.1		
		Thru	1,130	842	-288	26.8	80.6	672.3		
		RT	185	142	-43	11.7	146.1	415.2		
	N. Beauregard St NB	LT	460	381	-79	222.6	514.6	779.1		
		Thru	470	404	-66	50.7	351.4	782.6		
		RT	295	252	-43	9.7	155.1	405.3		
	N. Beauregard St SB	LT	135	146	11	96.6	80.6	291.8		
		Thru	190	193	3	79.5	35.8	148.9		
		RT	40	42	2	26.2	0.7	33.1		
N. Beauregard St & Mark Center Dr	N. Beauregard St NB	LT	50	49	-1	106.0	1.3	52.8	107.8	F
		Thru	1,195	1,028	-167	194.4	1565.0	1673.9		
		RT	415	341	-74	137.8	1426.6	1574.0		
	N. Beauregard St SB	LT	1,065	805	-260	37.8	386.9	808.6		
		Thru	425	309	-116	5.2	0.8	65.2		
		RT	80	61	-19	5.2	195.1	554.7		
	Mark Center Dr EB	LT	10	10	0	104.8	5.5	41.7		
		Thru	5	6	1	57.4	5.5	41.7		
		RT	5	4	-1	2.3	0.0	0.0		
	Mark Center Dr WB	LT	30	36	6	67.0	16.6	105.1		
		Thru	5	10	5	74.0	16.6	105.1		
		RT	20	25	5	22.3	16.6	105.1		
Seminary Rd & Mark Center Dr	Seminary Rd EB	LT	20	14	-6	65.8	4.7	49.9	67.1	E
		Thru	1,295	1,076	-219	23.9	72.1	484.3		
		RT	325	278	-47	3.8	6.4	287.1		
	Seminary Rd WB	LT	490	379	-111	64.1	142.6	612.7		
		Thru	2,445	1,772	-673	84.7	1402.2	1482.5		
		RT	90	55	-35	62.1	539.7	1187.3		
	Marc Center Dr NB	LT	30	28	-2	93.6	15.2	90.6		
		Thru	10	11	1	71.4	15.2	90.6		
		RT	200	177	-23	5.8	0.0	0.0		
	Marc Center Dr SB	LT	235	209	-26	203.2	340.6	541.8		
		Thru	80	70	-10	248.8	340.6	541.8		
		RT	50	47	-3	132.8	340.6	541.8		
I-395 SB On- Ramp & Seminary Rd	I-395 SB On- Ramp	LT	275	75	-200	5.1	0.6	57.1	44.6	D
		Thru	225	200	-25	1.2	0.7	59.6		
	Seminary Rd WB	Thru	870	738	-132	79.0	209.4	786.7		
		RT	500	444	-56	13.8	48.5	421.2		
I-395 NB Off- Ramp & Seminary Rd	I-395 NB Off- Ramp	Thru	1045	1023	-22	137.7	870.8	1613.3	86.3	F
		RT	200	188	-12	97.1	887.7	1619.5		
	Seminary Rd WB	LT	785	669	-116	21.1	35.3	309.7		
		Thru	360	144	-216	9.7	35.3	309.7		
I-395 NB On- Ramp & Seminary Rd	I-395 NB On- Ramp	LT	970	953	-17	22.0	126.4	353.1	49.8	D
		Thru	855	731	-124	11.0	126.4	353.1		
	Seminary Rd EB	Thru	385	337	-48	222.8	440.1	680.9		
		RT	690	609	-81	44.2	248.9	467.6		
I-395 SB Off- Ramp & Seminary Rd	I-395 SB Off- Ramp	Thru	235	46	-189	452.2	7.9	78.8	165.5	F
		RT	795	136	-659	1087.6	1111.4	1137.6		
	Seminary Rd EB	LT	270	230	-40	6.3	92.8	323.9		
		Thru	975	965	-10	59.8	92.8	323.9		

Therefore, with the limited interim improvement options available, another potential improvement measure during the interim years would be to consider implementation of Concept 4, which was discussed as one of the improvement options for 2013. Concept 4 would improve the operations at the critical intersections at capacity by providing the additional left turn lane at the intersections of Seminary Rd / N. Beauregard St along westbound Seminary Rd and also at N. Beauregard St / Mark Center Dr intersection along southbound N. Beauregard St. As shown in **Table 34**, based on the Synchro analysis, the added left turn lanes at the two intersections would improve the operations where it would operate over capacity without the improvement.

Table 34: 2011 AM Baseline without and with additional left turn lanes - Key Intersection MOEs

No.	Intersection Location	Control Type	Without Additional Left Turn Lanes AM Peak Hour Condition			With Additional Left Turn Lanes AM Peak Hour Condition		
			V/C	LOS	Delay (sec/veh)	V/C	LOS	Delay (sec/veh)
1	Seminary Rd / N. Beauregard St	Signal	1.06	F	105.1	0.90	E	64.5
	Eastbound			F	124.8		E	74.2
	Westbound			F	96.9		E	58.6
	Northbound			F	110.1		F	65.9
	Southbound			E	66.2		E	62.1
2	N. Beauregard St / Mark Center Dr	Signal	1.25	F	93.0	0.77	C	27.8
	Eastbound			E	63.5		E	63.0
	Westbound			E	65.3		E	64.7
	Northbound			D	48.6		C	33.7
	Southbound			F	141.3		B	19.9

8. Summary and Findings

8.1. Summary of the Conceptual Alternatives

This Mark Center (BRAC 133) Transportation Study has documented an evaluation of potential transportation improvements to the study area intersections and roadways. The corridors examined include Seminary Rd, bounded by George Mason Dr to the west and Library Ln to the east and N. Beauregard St bounded by Mark Center Dr to the south and W. Braddock Rd to the north. Also fifteen study intersections within the study area were analyzed. The analysis was completed in a two-tier approach. First, all concepts were evaluated using the traffic analysis software Synchro, and the results were then presented forward. Second, selected concepts were analyzed in depth using the micro-simulation traffic analysis software VISSIM. Initially, existing and 2013 baseline conditions were analyzed. Under the 2013 baseline condition, several potential conceptual improvement alternatives were evaluated which includes the following:

- Concept 1 : 2013 Project volumes with direct access ramp to the South parking garage
- Concept 2 : 2013 Project volumes with direct access ramp to Mark Center
- Concept 3 : 2013 Project volumes with direct access ramps to the South parking garage and Mark Center
- Concept 4 : 2013 Project volumes with added left turn lanes at Seminary Rd / N. Beauregard St intersection along westbound Seminary Rd (triple left) approach and at N. Beauregard St / Mark Center Dr intersection for southbound N. Beauregard St (dual left) approach without direct access ramps
- Interim Solution for the period between 2011 and 2013: Interim solutions identified in order to accommodate the project trips for the periods from BRAC occupancy anticipated by 2011 and the anticipated construction of the new ramp by 2013.

8.2. Findings

Capacity analyses for the four conceptual alternatives were conducted in an effort to evaluate and identify the benefits and disadvantages of each of the conceptual alternatives in terms of improving accessibility to and from the Mark Center site with the addition of BRAC 133 and future project trips.

The capacity analyses indicate that all of the evaluated alternatives would be expected to provide operational benefits. However, depending on the concept, the expected benefit and disadvantages would vary. Among the four concepts tested, Conceptual Alternatives 2 and 3 would be the most effective in terms of reducing overall delay while improving intersection operations at the critical intersections for both AM and PM peak hour conditions. Conceptual Alternative 1 and 4 would be the next most effective concept while Conceptual Alternative 4 would have constraint of mainly improving operations during AM peak hour conditions only. However, although Conceptual Alternatives 2 and 3 would be most beneficial in terms of improving the operations at the critical intersections by providing additional access points and thus diverting the project trips, the benefits obtainable under these concepts would require extensive improvements.

Based on the findings from Synchro capacity analysis, the micro-simulation was performed for the selected alternatives. Even though there are cases with some difference in MOEs based on the results from Synchro and VISSIM analysis due to the inherent differences between the two models, the overall findings from both analyses can be summarized as below:

- Although there are operational benefits, Concept 4 (additional left turn lane improvements) would still need new direct access, since some of the critical intersections serving the Mark Center site would operate over capacity without any additional direct access and would not be able to accommodate significant number of the additional project trip demand during AM and PM peak hour conditions. Concept 4 also has limitations in terms of improving the operations for the project trips egressing from the project site during PM peak hour conditions.
- Safety and roadway functioning operational issues would also be of a concern when having only Concept 4 to accommodate all the project trips. Therefore, additional improvement measures would need to be considered such as providing direct access ramps in combination with adding the additional left turn lanes, lengthening of the storage bays especially for the left turns at the critical intersections, lane widening for the left turn receiving lanes and improving the signage and pavement markings for these critical left turn movements.
- Although Concept 1 (direct access to the South Parking Garage) without additional left turn lanes would serve higher number of project trips than under Concept 4, additional left turn

lanes at the critical intersections would still be needed since the intersection is at capacity and would not serve all the project demand.

- Concept 2 can serve most of the demand without an additional left turn lane along the Seminary Rd westbound approach at the intersection of Seminary Rd / N. Beauregard St. Concepts 2 and 3 would maximize operational benefits in terms of traffic operations, but at the same time would be most difficult to implement from a construction standpoint. Although an additional left turn lanes may not be needed in the immediate foreseeable future, it would be beneficial to provide additional left turn lanes at the critical intersections in the long term to accommodate the additional trips generated from the potential future developments that may occur in the vicinity of the project site.
- To ensure the full operational benefits of implementing Concepts 1 or 2, it is important to take proper measures to prevent any spillback onto the I-395 southbound on ramp from the new direct access ramps. For Concept 1, as an example, measures would need to be taken at the security screening point to process the entering vehicles efficiently by providing multiple inspection gates and/or installing electronic screen vehicle tags as well as providing a sufficient storage length. For Concept 2, traffic circulation within the internal roadways would need to be maintained in an acceptable manner as well as providing a sufficient storage length for vehicles accessing the site.

Potential interim solutions were also investigated in order to accommodate the project trips for the periods from BRAC occupancy anticipated by 2011 and the anticipated construction of the new ramp by 2013. The findings from the interim solutions are as follows:

- Although some operational benefits would be attainable by increasing the storage length for the critical left turn movements, the intersections would still operate over capacity at the critical intersections. Therefore, expediting the construction of placing additional left lanes by 2011 (Concept 4) as an interim year improvement measure and then constructing the direct access ramps by 2013 or earlier would be one interim option to consider in order to improve the operations during year 2011 and ultimately in year 2013.

- Potential developments in Beauregard Corridor Plan Area which may be developed in the vicinity of the Mark Center may generate approximately 1,000 additional trips during AM peak hour and 1,500 additional trips during PM peak hour conditions. Therefore, even after the year 2013, it would be beneficial to keep the interim improvements in place to accommodate the additional trips generated from the potential future developments that may occur in the vicinity of the project site.